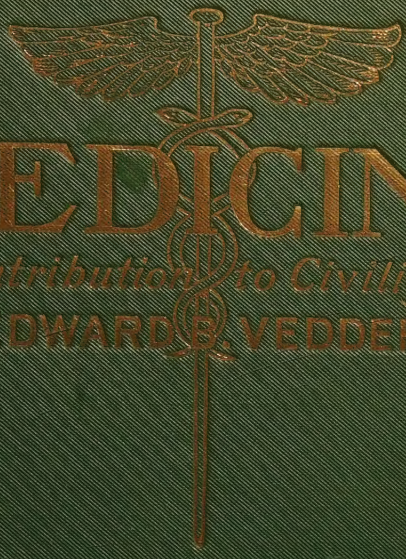

MEDICINE

Its Contribution to Civilization

EDWARD B. VEDDER

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MEDICINE

ITS CONTRIBUTION TO CIVILIZATION

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ITS CONTRIBUTION TO CIVILIZATION

BY

EDWARD B. VEDDER, A.M., M.D., D.Sc., F.A.C.S.

Lieutenant-Colonel, Medical Corps, U. S. Army

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PREFACE

It has been stated that "the progress of mankind depends on the success with which the laws of phenomena are investigated and on the extent to which a knowledge of these laws is diffused." The present mechanical and electrical age in which we live is based upon such scientific discoveries. Equally, a large part of the greatly increased comfort and safety that we enjoy today is the result of the phenomenal advances that have been made in the medical sciences during the past fifty years. Owing to the wide adoption of the experimental method, we have learned more concerning the origin and prevention of disease during this short period, than had been acquired during all the preceding centuries.

All of the medical sciences have shared in this advance, if not always equally; but the application of these discoveries has been incomplete because the knowledge of these discoveries has not been sufficiently diffused. There have been great advances in sanitation, yet the science of medicine is still far in advance of its sanitary application. The health officer daily sees people suffering from diseases like rabies, smallpox and typhoid fever that he knows could be eradicated, but if he wishes to retain his office he can adopt only such measures as will be supported by popular opinion, and he is hampered by lack of funds.

A great improvement in health may be purchased at a reasonable price. In 1916 the Russell Sage Foundation published the cost of health departments in 219 cities of more than 25,000. The average per capita expenditure for health was 32.7 cents. In 1923, the health departments of the 100 largest cities in the United States expended 87.4 cents per capita for the 32,155,096 people living in those cities. This sum spent for public health represents only 1.77 cents out of each dollar of total municipal expenditures. A great reduction in the incidence of infectious disease has been accomplished with these small sums.

Larger appropriations have produced even better results. In 1904, the death rate in the Isthmus of Panama was as high as

71 per thousand. Eight years later it was only 7.31 per thousand. This improvement was effected at a cost of $3.65 per capita per annum. In the tuberculosis demonstration conducted in Framingham, Massachusetts several years ago, the per capita expenditure for community health was raised from 40 cents to $2.40. As a result the general death rate dropped 9 per cent, the infant mortality rate 40 per cent, and the tuberculosis death rate 68 per cent.

Such isolated achievements indicate that similar results may be obtained generally by simply applying our present knowledge more effectively; but such an advance in sanitation can only occur when the general public becomes convinced of this possibility and learns to demand it and pay for it.

A further great improvement in health is possible by a more general understanding and application of the principles of personal hygiene and the correction of obvious defects detected by periodic physical examinations of the apparently healthy.

In order to accomplish these purposes, medicine with its ideals and achievements must be popularized. It is the aim of this book to do this and to present the more important facts of preventive medicine accurately, but in plain English devoid of technicalities, and at the same time to inject a little human interest. Great care has been taken to be accurate, and no statement has been made for which there is not what is believed to be good authority. Some of the more important references have been given.

I am indebted to Dr. F. F. Russell of the International Health Board for valued criticism of the first three chapters, and to Dr. Joseph C. Bloodgood of Baltimore for a critical reading of the chapter on cancer.

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PART I. THE CAUSES OF DISEASE

CHAPTER I

Predisposing Causes

There are some diseases, plague, smallpox and measles, for example, whose organisms are so virulent that the disease almost certainly results when an unprotected person receives the infection. But this is not true of many other diseases, such as tuberculosis and meningitis, and probably typhoid fever. All individuals exposed to these infections do not contract the disease, but only those that are specially predisposed to the infection. The organism causing the disease is called the direct or immediate cause; the factors that render a person more liable to infections or other diseases are called the indirect or predisposing causes. A proper mode of life, in other words, personal hygiene will often remove the predisposing causes of infectious diseases and the direct causes of certain other diseases such as those caused by an improper diet. As a rule the individual is unable alone to avoid the immediate cause of infectious diseases. For this, the united effort of the community, or sanitation, is required.

It is proposed here to discuss some of the predisposing causes of disease with the appropriate rules of personal hygiene.

HEREDITY

Heredity is an important predisposing cause of certain diseases. Inherited characteristics are first racial and secondly individual. All peculiarities that define every species are inherited, otherwise we should have no species, but might obtain figs from thorns or grapes from thistles. On the contrary cows always produce cows and men produce men. This means, of course, that all of our most important characteristics are unalterably fixed by heredity. Included in these inherited racial characteristics is the natural immunity against various diseases possessed by each species. Men are liable to typhoid, cholera and syphilis, while animals are not; the human race is naturally immune to a whole host of animal diseases.

Of individual hereditary characteristics, longevity is an example. Length of life is known to vary considerably in families. In some families the bodily machine inherited is worn out after fifty years, while in others the machine lasts longer. Baldness affects the male members of certain families at an early age. Mental characteristics are also inherited. Statistics indicate that genius runs in certain families, while in others, feebleminded-ness is equally certain to appear. Strength or weakness of will, and capacity or incapacity for the highest intellectual pursuits occur regularly in certain families and must be inherited, just as are the mental qualities of the bulldog or the blood hound. Among the individual characteristics that are inherited there are many abnormalities and diseases, which may be classified as follows:

1. Malformations such as polydactylism (more than the proper number of fingers), webbed fingers, abnormal length or shortness of certain bones.

2. Defects such as albinism (lack of pigment), myopia (near-sightness), squint, some forms of deaf mutism, caused by hereditary defects of the inner ear, and the curious bleeders' disease (haemophilia), in which only the males are bleeders, but the male who is a bleeder cannot transmit the defect to his children. On the other hand, the females of a bleeder's family, though they do not suffer from the defect, do transmit it to their children.

3. A susceptibility to certain infections, such as the liability to tuberculosis. Certain families have a tendency to obesity, gout and possibly diabetes. The essential feature in such cases is not the inheritance of the disease itself, but of a peculiar habit or type of body or a constitutional weakness that predisposes to the disease in question.

4. Nervous stigmata. Certain palsies run in families as do also epilepsy, hysteria, and other neuroses. The men in certain families are prone to become drunkards. The drink habit is not transmitted in these cases. This instability often manifests itself differently in different generations. Thus, this temperament may be the cause of alcoholism in one generation and of severe neuroses in the next. A certain nervous instability is

also often associated with certain types of genius. The idiosyncrasies of musicians, artists, poets and inventors are so well known as to form a subject of jest almost as common as the mother-in-law joke.

But although there is so much similarity between parents and their offspring, there are also striking differences. No child is ever exactly like either of its parents, and this is the clue to the problem of heredity. Among bacteria and protozoa that reproduce asexually by simply dividing, one individual is as like another as two bird shot, but sexual reproduction introduces variations. There are roughly two billions of human individuals on the earth, no two of whom are precisely alike either physically or mentally. It is this variation that makes the progress of the race and civilization possible. The hereditary transmission of characteristics has long been known but the mechanism of heredity has been known to us only a few years. Only in 1852 was it clearly established that the spermatozoön penetrates and fuses with the ovum, so that only since that time have we known that the new individual is the result of the fusion of a single cell from the male with a single cell from the female parent. The new individual begins its existence from the moment of this fusion. Several important conclusions may be drawn from this fact.

1. There must be some physical basis in the spermatozoön and ovum upon which the transmission of hereditary qualities depends.

2. Any modification of this new individual after the moment of fusion of the two parent cells, is an acquired characteristic; it is not hereditary.

From this it follows that infectious diseases, such as tuberculosis, smallpox or syphilis are not inherited in the strict sense of the word. Though they may be present in the child at birth, they are acquired from the mother during the period of gestation, and are more properly called congenital.

THE PHYSICAL BASIS OF HEREDITY

In 1865, the Augustinian monk, Gregor Johann Mendel, announced the results of his experiments on the hybridization of

peas in the form of a law of inheritance. Mendel confined his attention to seven constant characteristics of peas, such as whether the seeds were smooth or wrinkled, the color of the seeds, of the flowers, etc. Having determined that these characteristics were constant for certain varieties, Mendel then crossed one variety with another by carefully removing the unripe stamens with their pollen from the flowers of one variety, and dusting upon the stigmas of such flowers the pollen of a different variety, crossing varieties that differed in one of the characters mentioned above. He then studied the offspring of this cross through several successive generations.

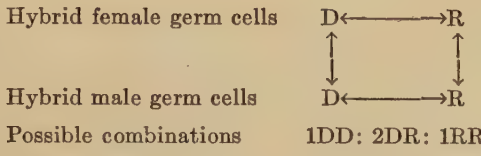
In every case he found that the offspring from such a cross showed only one of the two contrasting characters of the parent plants. All were round-seeded, yellow, or tall, although one of the parents had wrinkled seeds, green seeds, or a short stem. The characters transmitted unchanged in the hybrid were called *dominant* and those that became latent, *recessive*. But these hybrids when self-fertilized gave rise to a second generation which showed the dominant character in some and the recessive character in others according to a definite rule, which was found to be 1 dominant, 1 recessive, 2 hybrids.

In certain cases it has been found that the hybrids differ from either parent, but in successive generations split up into both parental types and into the hybrid according to the same definite rule. Thus, if a white flower was crossed with a red flower, all the hybrids had pink flowers. But when these were crossed, the second generation produced one white, one red and two pink.

Mendel concluded that individual germ cells are always pure with respect to any pair of contrasting characters, even though those germ cells have come from hybrids in which the contrasting characters are mixed. A single germ cell can carry the factor for red flowers or white flowers, for green seeds or yellow seeds, but not for both pairs of contrasting characters. These factors separate in the formation of the germ cells so that one half of all the germ cells of a hybrid formed by crossing the white and red flowers carry the factor for white and the other half for red.

Thus, since all germ cells are pure with respect to any particu-

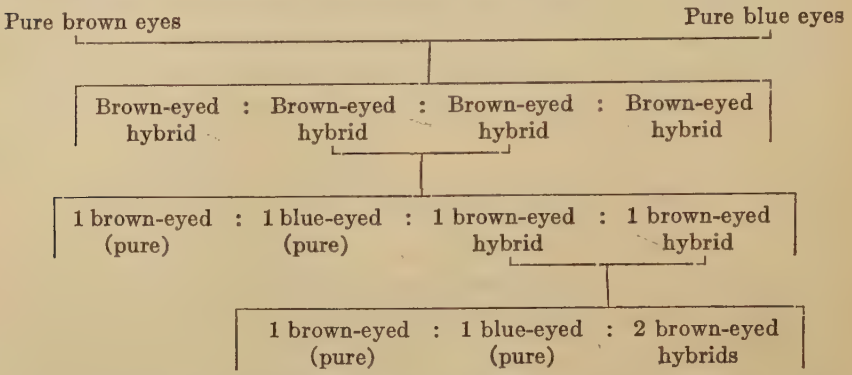
lar character, the hybrid offspring of any two parents with contrasting characters will produce in equal number two classes of germ cells, one being the dominant and the other the recessive factor. The chance combination of these two classes of male and female germ cells will yield on the average, one union of dominant with dominant, one union of recessive with recessive, and two unions of dominant with recessive, thus producing the typical Mendelian ratio 1DD: 2DR: 1RR. This is shown in the following diagram:



In other words, one half of the progeny 2DR will breed true to the parental characters of the hybrid, while the other half will be divided equally between offspring resembling the dominant factor of one grandparent or the recessive character of the other grandparent. This explains why children are so often observed to resemble their grandparents in certain ways.

For at least thirty-five years this remarkable contribution of Mendel remained unnoticed, but in 1900, three botanists, de Vries, Correns, and Tschermak simultaneously rediscovered this principle and confirmed Mendel's results in every respect. It should be said here that these results can only be obtained when the experiment is commenced with pure races. Inheritance in man is just as truly Mendelian as is inheritance in peas, but it cannot be demonstrated so conclusively, not only because no one lives long enough to perform such an experiment on man, but because men are so intercommingled that there are few individuals with a pure heredity with regard to any single characteristic. For example, brown eyes or blue eyes, black hair and red hair are unit characters transmitted in accordance with the Mendelian law. Brown eyes are caused by the presence of pigment. Blue eyes result from an absence of this pigment. This pigmentation producing brown eyes is a dominant characteristic. If two parents are a pure brown eyed strain, all of their offspring will have

brown eyes. If they are a pure blue eyed strain, all offspring will have blue eyes. Now suppose one parent is a pure brown eyed strain and one pure blue eyed. All offspring will have brown eyes, because that color is dominant. But they will be hybrids and if mated together, their offspring will have 1 pure brown eyes, 1 pure blue eyes and 2 hybrids (brown eyes).


Pure brown eyes
Pure blue eyes
Brown-eyed hybrid : Brown-eyed hybrid : Brown-eyed hybrid : Brown-eyed hybrid
1 brown-eyed (pure) : 1 blue-eyed (pure) : 1 brown-eyed hybrid : 1 brown-eyed hybrid
1 brown-eyed (pure) : 1 blue-eyed (pure) : 2 brown-eyed hybrids

When we examine the process of fertilization more closely, we find an actual physical basis for the transmission of hereditary qualities. The ovum and spermatozöon, like all single cells consist essentially of a membrane containing protoplasm, in the midst of which is a kernel or nucleus. This nucleus contains a network composed of a substance called chromatin, because it stains deeply with certain dyes. This nuclear chromatin is the regulator of the vital activities of all cells and in the sexual cells in addition contains and transmits the hereditary qualities.

After the nucleus of the spermatozöon has penetrated the egg, it approaches the nucleus of the egg and fuses with it, and so the chromatin from the male cell fuses with the chromatin from the female cell. The egg so fertilized now divides and forms two cells; but the chromatin has previously become arranged in such a way that each of the daughter cells has received half its chromatin from the male and half from the female parent. This process continues in every subsequent cell division, so that in the adult body, every one of the billions of cells of which it is composed contains equal parts of chromatin derived from the father and

from the mother. Since this chromatin governs all the activities of each cell, it is obvious that the new individual must be a composite of qualities received from the paternal and maternal chromatin.

CONTINUITY OF GERM PLASM

Not only so, but there is an actual continuity of germ cells and chromatin from one generation to the next. Adult organisms do not manufacture germ cells, but on the contrary at a very early stage of development germ cells are set apart, containing part of the original chromatin that was contributed by the parents. It is true that later these cells multiply in the sex organs of the newly developed individual, but while the chromatin increases in quantity, it was originally all derived from the parents and contains chromatin having all the characteristics of the parental chromatin. The chromatin derived from the two parents, was in turn derived from the chromatin of four grandparents, and so ad infinitum. It is easy to see how bodily and mental characteristics may in this way be contributed by more or less remote ancestors.

"Heredity is the continuity from generation to generation of certain elements of germinal organization. Inheritance is the sum of all those qualities which are determined or caused by this germinal organization." (Conklin.)

THE CAUSE OF SEX

When the chromatin rearranges itself prior to cell division it breaks up into pieces called chromosomes, and the number of chromosomes found in every cell during cell division is constant for that species. About 1902 it was found that two kinds of spermatozoa were found in certain animals in equal numbers. One contained an "accessory" or odd chromosome and the other lacked it.

It was suggested that this odd chromosome was a sex determinant. It was later found that there was only one type of egg since every egg contained the accessory chromosome. Wilson pointed out in 1905 that if an egg were fertilized by a sperm con-

taining an accessory, two accessories would be present in the progeny, this causing the production of a female, while if the egg were fertilized by a sperm without an accessory, only one accessory derived from the egg would be present in the progeny, which would be a male. In man sex is determined in a similar manner. Every egg contains 24 chromosomes. Half of the spermatozoa contain 24 and half 23 chromosomes. If the egg is fertilized by a sperm of 24 chromosomes, a female will be produced; if fertilized by a sperm with 23 chromosomes, a male results. Thus, in the long run, equal numbers of males and females will be born.

From this it will be seen that sex is determined at the instant of fertilization, and the futility of attempts, which have often been made, to produce male or female offspring by modifications of diet, hygienic rules, or other methods, may be appreciated. In this connection we may also refer to the so-called maternal impressions in which many devoutly believe. That is, that some horrid sight or shock experienced by the mother during pregnancy will often produce some marking in the child. The new individual begins its independent existence at the moment of fertilization, and thereafter even though nourished by maternal blood, it is just as separate a life as it will ever be. We might as reasonably expect a maternal impression to affect a child after birth.

Unfortunately heredity as it affects disease cannot be modified after conception has occurred either. The eradication of bad hereditary traits can only be effected by a reasonable practise of eugenics.

Allusions to eugenics make many practical people smile. The idea seems fanciful. No sensible person supposes that we shall attempt to breed a superman on the same principles that we breed dogs and horses. But we can at least make a serious effort to segregate the feebleminded and those having well defined criminal tendencies and thus prevent them from multiplying their kind. Eugenics is being practiced daily by parents who endeavor to provide that their children marry into families of good lineage. Such marriages may be arranged more intelligently if the mendelian law of inheritance is understood. There are few people who do

not inherit some undesirable quality of body or mind. If two individuals who both have the same hereditary taint or predisposition to disease marry, this tendency becomes fixed in their offspring. This constitutes the danger in consanguineous marriages (cousins). On the other hand conspicuous abilities also tend to become fixed by such inbreeding. It is certainly a practical suggestion in any question of marriage to give as much consideration to the laws of inheritance and the elimination of undesirable hereditary characteristics as is given to social and financial eligibility.

MORTALITY AT VARIOUS AGES

The general death rate varies with age, in much the same way for all nationalities. The death rate is very high in infancy, drops rapidly to a very low level at the age of ten. Thereafter deaths increase slightly but continuously up to the age of about sixty, after which deaths increase very rapidly. The general death rate is composed of deaths from all diseases, but as is well known certain diseases are more apt to occur at definite age periods.

In Sweden where accurate statistics have been kept for a long time, 205 out of every 1000 children born died during the first year in 1751–55, but from 1896–1900 this mortality was reduced to 100. In Massachusetts in 1851, 133 children out of each 1000 born died during the first year; in 1920, 91 per 1000 died. Therefore, although infant mortality has been greatly reduced, almost 1 child in 10 still dies during the first year of life.

This very high infant mortality is largely due to congenital syphilis, to gastro-intestinal diseases resulting from infections or improper feeding, and to the infections like measles, whooping cough, scarlet fever and diphtheria which are so commonly found in childhood that they are generally called children's diseases. These facts are generally known but not fully realized. Thus, measles is known to be a disease of childhood, but few realize how very soon children usually meet this adversary. In an epidemic in 1892–1894, in a district with a population of 35,000, and with good reporting of cases, the total cases were 2031 and

deaths 125. Of these 2031 cases, 1401 or about 69 per cent occurred under the age of five; 560 further cases occurred at ages five to ten, and only 39 cases occurred among children over ten years of age. (McVail.)

Measles is like smallpox in that its infectivity is so great that any unprotected person exposed to the infection almost surely contacts the disease, and of course children that have never had an attack are unprotected. It is chiefly for this reason that it occurs at such an early age. In the prevaccination days, when smallpox was practically universal, it too was usually a children's disease. The fact that measles is more or less inevitable frequently leads parents to make no attempts to avoid the infection, feeling that as it is inevitable it might as well be over with as soon as possible, when it will cause less interference with schooling. This is a serious mistake, because the mortality is much higher at the earlier ages. Thus in the epidemic referred to above, of 233 cases between one and two years of age, 46 or 19.7 per cent died. Between two and three years, there were 354 cases, with 36 deaths, or 10.2 per cent. From three to four the percentage of deaths was 4.9 per cent. From four to five, 1.5 per cent, from 5 to 10, 1.1 per cent. Of the 39 cases in children over ten years of age, none died.

That is, the longer the disease can be put off, the lower the mortality. We can do nothing to correct an infant's age and susceptibility to measles; only time can do this. But we can shield it from infection in every possible way until it reaches an age when the disease is not dangerous to life. This principle applies equally to other children's diseases, such as whooping cough, scarlet fever and diphtheria. All of these diseases are transmitted by contact with other individuals having the disease, and a very large percentage of these contacts may be avoided by the exercise of a little care.

Maturity is also peculiarly susceptible to certain infections. Thus the figures for the United States Registration Area in 1914, based on total deaths of 898,059, indicate that the highest proportionate mortality for tuberculosis was for the group from twenty to twenty-four years of age; although the percentage of deaths

from tuberculosis is high between the ages of ten and fifty. Similar census figures indicate that the greatest number of deaths from typhoid fever occur in the age group twenty to twenty-nine years. When we know that certain diseases are more apt to be acquired at particular ages, we can take the proper precautions. Typhoid fever may occur at any age, and hence anti-typhoid inoculation is desirable at any age. But from fifteen to thirty years of age, the protection so conferred becomes peculiarly desirable. Young soldiers have always been highly susceptible to typhoid infection, yet the disease has been eradicated from the United States Army by systematic anti-typhoid inoculation of all recruits.

After maturity, degenerative processes begin. Heart disease, cancer, apoplexy and Bright's disease become more frequent after middle age.

The old are peculiarly susceptible to disease caused by organic degeneration. With advancing years all tissues atrophy or waste away to a greater or less extent. The skin becomes thinner and wrinkled, the muscles smaller and weaker, and there is a loss of weight of all organs, including the brain, and a diminution in all bodily functions. Most important of all, the arteries become gradually harder and less elastic so that the circulation of all organs becomes impaired. This is so constant a change of senility that it has given rise to the saying that "a man is as old as his arteries." Of course, these changes occur more rapidly in some individuals than in others and senility is not at all a question of years. Some men are as old at thirty-five or forty as another at seventy or seventy-five.

Advancing years predispose to certain infections such as chronic bronchitis and broncho-pneumonia. We have one cold after another all our lives. But as we get older, we find that a cough always hangs on longer and longer, until a chronic bronchitis is established. This is one of the commonest affections of the aged. Throughout life the slight injuries caused by a cold are constantly received and as constantly more or less perfectly repaired. But repair after injury is rarely perfect. Often some scar tissue is left behind, and the repaired tissue is more susceptible to infec-

tion. With advancing years the ability to repair injuries becomes diminished. Thus injury is progressively easier to acquire and repair constantly less perfect.

Old age itself is seldom or never a true cause of death, which is usually caused by some infection like pneumonia which has been called "the friend of the aged," the rupture of a degenerated blood vessel in the brain (apoplexy) or the advanced degeneration of some organ that is indispensable to life. The heart and kidneys are peculiarly liable to such degenerative processes because they are so closely allied in function with the arteries. Hardening of the arteries means throwing an additional burden upon the heart, and the kidneys are affected because such blood vessels in that organ are less permeable. Such a combined condition is called cardio-renal-vascular disease by the doctor, and is one of the common degenerative processes of age. Its beginning is often heralded by a rising blood pressure, which is the reason that this symptom is given serious consideration and demands some change in habits of life. It is a sign that we are not as young as we used to be, and that it is time to avoid hard exercise, the strenuous life, and wine, women and song. We are here reminded of the man who was so advised by his physician and promised, "Doctor, I will never sing again."

The tissue changes caused by age increase susceptibility to cancer. Although cancer is very rare below the age of thirty and relatively uncommon until forty, yet of those who live beyond this period, approximately one out of every ten will die of cancer.

SEX

Men and women suffer equally from most diseases, but there are some exceptions. Chlorosis, a peculiar form of anaemia, affects only young girls, and it is doubtful if males are ever affected. The nervous system of women appears to be more delicately organized than that of men, and nervous disorders such as hysteria and migraine or paroxysmal sick headache are more apt to occur in women. Thyroid disturbances are seen more often in women. Simple goitre, myxoedema and exophthalmic goitre

are all from six to eight times more common in women than in men. Three fourths of the cases of gall stones occur in women. Cancer of the breast and uterus constitute the major portion of all cancer in females.

Men suffer more often from syphilis and its complications such as paresis, locomotor ataxia and aortitis and aneurism. Gout, diabetes and cancer of the stomach and bowels are all more common among men. Pernicious anaemia a progressive and fatal form of anaemia, of unknown cause is twice as common in men, and the same is true of Addison's disease and leukaemia. Men are naturally more subject to occupational diseases such as lead poisoning, and to injuries.

PERSONAL PECULIARITY

Certain individuals are poisoned by articles of diet known to be wholesome, such as strawberries, shellfish, or eggs. If a person having such an idiosyncrasy eats the article that is noxious to him, he may suffer an attack of hives (urticaria), or it may cause asthma. People subject to hay fever belong in this class. This very distressing condition is caused by the pollen of certain plants which cause no symptoms in the majority of people.

The exact cause of these idiosyncrasies is still a disputed subject. Perhaps the majority opinion is to the effect that because of the personal peculiarity, the proteins contained in these substances are absorbed unchanged into the blood stream where they act as poisons (anaphylaxis), while in the case of most persons, these proteins are destroyed in the ordinary process of digestion. This is only a partial explanation and is by no means satisfactory. Other investigators claim to have shown that this idiosyncrasy is an inherited characteristic. Even if true this does not explain the condition either. We are forced to conclude that the scientific explanation of this condition is most unsatisfactory. But most people are not wildly excited about scientific discussions, but are more interested in what can be done about it. In this case, there is a very definite answer. It has been found that when an extract of such articles of food, pollen, or other irritating

substances is made, and a minute quantity of this extract is rubbed into a small scratch on the skin, that it will cause in a few minutes an urticarial wheal with much itching of the skin, if the person has an idiosyncrasy to that particular food or substance; whereas it has no effect whatever on the skin of a normal person. Many such extracts have been prepared and are now available, and it is therefore possible to determine with considerable accuracy the substances that cause the irritation in particular cases. If it is shown by such a test that strawberries or oysters, or some other article of diet is the cause of urticaria or asthma, then the victim is enabled to live in comfort by simply excluding such substances from the diet. The emanation from horses is prone to cause asthma in some people, so that simply driving behind a horse will bring on an attack. Such people should leave horses alone and travel in an automobile. In other cases it has been found that the goose feathers in a pillow were capable of causing an asthmatic attack. When cotton pillows were substituted, the asthma improved.

Hay fever is more difficult to treat. It is easy to determine which pollens are causing the symptoms by the same test, but unfortunately the plants causing it are often ubiquitous and it is almost impossible to avoid them. It can be done, however, by taking a sea voyage, or otherwise traveling to a locality where the plant causing the damage does not occur. An attempt has also been made with more or less success to immunize hay fever victims against the pollen. If this is done a month or two before the plant causing the trouble blooms, a considerable degree of relief is often experienced. Little can be accomplished by such an immunization commenced after the symptoms of hay fever have appeared, for it takes several months to acquire such immunity. As hay fever always appears at a certain season, coincident with the blooming of the plant that causes the damage, a hay fever victim always knows the time of the year when the symptoms will appear, and may travel or prepare himself by a prior course of immunization. Unfortunately both remedies are expensive, and are not available to everyone.

THE SEASONS AND THE WEATHER

It is known to all that many diseases are seasonable. Typhoid fever has its greatest incidence in late summer and early fall. Cholera has a definite season. In the Philippines it occurs more or less regularly every year in August and September toward the end of the rainy season, and disappears as regularly during the cool months of November and December not to put in an appearance again until the next August. There are reasons for this incidence. In the case of typhoid, all during the summer people are very thirsty and drink more or less carelessly and largely of water, milk and other beverages from questionable sources. Many people leave their homes during this period and go into the country for a vacation where they can get fresh country air just off the manure piles, and drink good spring water from right next to the cesspool. They return to their homes and about two weeks later (the proper incubation period for typhoid) they develop typhoid fever. Sanitation in the rural districts is usually far behind that of cities and towns. In the case of cholera the explanation is somewhat different, but is still the result of improper disposal of alvine discharges. Native villages cannot afford a proper sewer system and depend upon the family pig for scavenger work. There are always cholera carriers, who ordinarily do no damage. But the heavy rains carry these discharges to the streams, where the natives bathe, wash clothes, and catch small fish, shrimps, etc., which are frequently eaten raw. Soon there are a few cases of virulent cholera. Usually there are only these sporadic cases, but should no attention be paid to these the disease spreads rapidly and may attain epidemic proportions.

Several years ago, the National Research Council appointed a committee to study the effect of the atmosphere on man. They investigated the relation of the weather to deaths in New York City. They used the data for the six years from 1883–1888 because those were the latest years for which statistics of daily deaths were available. This study showed: (1) that the highest death rates occur on the colder days; (2) the most favorable mortality is on those days when the temperature averages be-

tween 60° and 75°; (3) there is a very rapid increase in mortality with increasing temperature beyond 75°.

The cold weather exerted its maximum effect, not on the day at which it occurred, but several days later, and the unfavorable effect of cold weather persisted for many days after its occurrence. During the years covered by the investigation, the death rate during the coldest days of winter was more than 20 per cent greater than on days when the temperature was about 65°.

Almost all of the excess mortality of the winter months is caused by the respiratory diseases. Colds, influenza, pneumonia, measles and smallpox and all diseases spread by the secretions from the respiratory tract are more common during the winter. In explaining this seasonal prevalence of the respiratory diseases we have several factors to consider. The first explanation that naturally suggests itself is that in winter we often become chilled and thereby our resistance to these infections is lowered. Every one susceptible to colds knows that sitting in a cold draught is extremely likely to precipitate a cold. Rabbits and guinea pigs often develop pneumonia when they are left out of doors in the winter, and suffer much less from pneumonia if they are kept in a warm room. Fowls are normally immune to anthrax, but if they are kept standing in cold water for some time, they are rendered susceptible to this infection. The effect of exposure in lowering resistance to certain infections is therefore not only a matter of daily observation but is capable of experimental proof.

This explanation is undoubtedly correct, but it is not the whole explanation. Colds are infectious and exposure to cold will not by itself produce a cold. Polar explorers do not suffer from colds as long as they remain in the arctic regions (i.e., where there are so few people that they are not continually exposed to infection), but when they return to civilization develop colds again. It is possible to suffer great extremes of cold without developing pneumonia, if the infection is not present. We receive the infection from other people. When we sit in a draught, the cold air striking the skin causes a reflex congestion or swelling of the mucous membrane of the nose. If no infection be present, this congestion passes off in a few minutes or hours. But if the virus that

produces a cold has been recently received, this congestion of the nose provides a favorable condition for its rapid growth, and a cold is the result. Though exposure to cold and wet are singularly predisposing causes of influenza and pneumonia, both diseases often occur without any such exposure. The onset of acute pneumonia is nearly always marked by a rather severe chill. This symptom of the disease occurs in cases that have suffered no exposure to cold, and must not be confused with the results of exposure. The current belief that a bad cold may develop into pneumonia is also scientifically incorrect although it has some basis in observed facts. Since the organism causing a cold and the organism producing pneumonia are entirely different, one cannot turn into the other any more than lions can turn into tigers. But a severe cold may so reduce a patient's vitality as to render him unusually susceptible to a later or superimposed pneumococcus infection and so he develops pneumonia. It is common sense, therefore, that a person having a cold should take care to avoid further exposure, and should in general take extra precautions to avoid further infection.

It must not be supposed, however, that because lowered resistance plays so important a part in the production of such diseases as pneumonia and tuberculosis, that it is equally important in all respiratory infections. Measles certainly and smallpox probably are conveyed from person to person through the secretions of the respiratory tract. They are therefore from the etiological viewpoint just as truly respiratory diseases as are pneumonia or tuberculosis. Yet their infectivity is so great that all individuals who have never had the disease appear equally susceptible. they are commonly epidemic during the winter and disappear during the summer. In view of their known peculiarity of attacking the robust, no one supposes that exposure to cold, or fatigue, or insufficient food, the factors that usually lead to lowered resistance, are responsible for the occurrence of measles and smallpox in the winter months. Yet obviously the weather must have some influence on the course of these epidemics.

When the weather gets below 60°, we close the windows and light fires. Is there any connection between our system of heat-

ing and ventilation and such diseases as measles and smallpox? It appears that there is a very direct connection. With our modern steam heat and hot water, as well as with the old-fashioned stove, ventilation in the winter is reduced to a minimum. People are shut up in rooms having no free movement of air. If infection is introduced into the atmosphere of such a room, by persons sneezing or coughing, the infection remains there. When a person sneezes or coughs, they discharge a spray from 2 to 5 feet about them. In the intensely dry atmosphere of such a room, the spray soon evaporates and leaves the virus floating about the air to be breathed by every person in the room. Measles spreads particularly among the children in a school. Is it remarkable, if an infected child enters a school room having doors and windows closed and spends one day sneezing and coughing into the room, that every other child in that room has been exposed to the contagion?

Nor have we said the worst concerning the atmosphere in our heated houses. When outdoor air is heated so as to maintain an even temperature of 75°F., its capacity for absorbing moisture is greatly increased, and it will take up moisture from any moist object with which it comes in contact. Air at 25°F. that is saturated with moisture and then heated to 70°F. would need half a pint of water for each 1000 cubic feet to give it a humidity of 65 per cent. In the hot air furnaces, there was supposed to be a pan of water to supply this moisture to the air. But even if it was kept filled, which it seldom was, the amount of water was insufficient. In our steam and hot water heated buildings not even this provision is made. When the atmosphere contains water vapor in sufficient quantity a temperature of from 65° to 70° is quite comfortable. In very dry air a temperature of 75° to 80° must be reached in order to keep people at rest sufficiently warm. If there are old members of the family, they frequently complain of cold at temperatures below 85°F. The avidity of such a superheated atmosphere for water may be imagined. Water is abstracted from even kiln-dried furniture so that it cracks and the joints come apart. Leather covers of books crack and fall to pieces, and plants die. Such an atmosphere

abstracts all the moisture from the nose and throat, leaving the mucous membrane dry and irritated. They are therefore highly susceptible to bacterial invasion. The film of mucus with which they are normally covered, catches bacteria just as sticky fly paper catches flies. Such bacteria are commonly removed from the respiratory tract with the excess secretion. When this mucus is dried up, there is nothing to prevent organisms from being breathed with the inspired air to the depths of the lungs, where they are caught and retained and will set up inflammation if they are pathogenic organisms of sufficient virulence.

Excessive heat has numerous other physiological effects. High temperatures drive the blood from the skin to the deeper structures, causing pale complexions. It has long been observed that in the tropics people became very white. It used to be supposed that this pallor was due to anaemia, but blood counts indicate that this is not the case. When these people return to a cold climate, color quickly appears in the cheeks. *The complexion is a good index of normal skin circulation.* It is possible that if our houses were not superheated, the women would not be compelled to use so much rouge.

We see therefore several reasons connected with the ventilation and heating of our houses together with the overcrowding that often occurs in such buildings as schools, churches, and theatres, to account for the increased prevalence of all respiratory diseases, during the winter months. They surely have every opportunity to spread.

Can anything be done about it? We can do nothing until we demand that builders improve our heating and ventilating systems. A number of devices for humidifying the air have been invented. Radiators may be encased in boxes having a water container and evaporation may be hastened by providing such containers with cotton wicking which will draw up the water by capillarity just as the wick of a lamp draws up oil. Such a device will not only add materially to comfort and health, but will also reduce the annual coal bill considerably since a temperature of 65° will probably seem quite warm enough when the atmosphere has the proper amount of aqueous vapor. The saving is

considerable, because if the outside temperature is 30°, it requires only a moderate amount of fuel to raise the temperature to 65°, but it requires a disproportionate amount of fuel to raise the temperature from 65° to 80°. The Roman system of heating was to heat the floors and walls so that these large surfaces became the source of heat. Architects and engineers are considering the modern use of this method by which heat is distributed more evenly than from radiators.

The rapid increase in mortality at temperatures above 80° is also interesting. This is partly accounted for by the fact that in every large city there are a considerable number of cases of heat prostration and sunstroke every summer. The infant mortality is also greatly increased owing to the greater difficulty of providing pure milk during hot weather when bacterial multiplication is rapid, and to loss of sleep and general discomfort in overcrowded districts.

During dry summer weather there is also a greatly increased amount of dust. This dust which is so generally disseminated in the atmosphere not only may carry certain infectious organisms, such as the bacillus of tuberculosis, but it has also been found that dust, particularly mineral dust, is an irritant to the lungs and an excitant of pulmonary tuberculosis. In most large cities and some towns, the dust nuisance is abated by frequent sprinkling of the streets.

Efficient pasteurization and icing of milk has proven very effective in reducing the infant mortality during the summer months. Electric fans have nearly obviated the effects of high temperature for those that can afford them. There remains the interesting possibility that our heating system may be combined with a cooling system. The same pipes that carry hot water during the winter could carry cold water during the summer. A small refrigerating plant in the basement would probably cost less than a furnace. The time may come when we will be able to keep our houses at an even temperature of 65° the year around, with proper ventilation and the correct amount of aqueous vapor. If such a time does arrive, we shall have reduced our excess mortality for both cold and hot weather to the low level observed at tempera-

atures from 60° to 75°, and the joke that "everybody talks about the weather, but no one does anything about it," will have lost its point.

OVERCROWDING

One of the facts concerning which there can be no debate is that both morbidity and mortality rates increase rapidly when people are too closely associated. There can be little doubt that the majority of this increased rate is due directly to the overcrowding, yet it is very difficult to obtain figures to show this, because overcrowding is generally associated with other factors such as poverty, insufficient food and clothing, and other insanitary conditions. Table 1 (Abbott, Hygiene of Transmissible

TABLE 1

Relation between death-rate and density of population in England and Wales

	PERSONS TO 1 SQUARE MILE						
	166	186	379	1718	4499	12,357	65,823
Mean death-rate at all ages.....	16.75	19.16	21.88	24.90	28.08	32.49	38.62
Mean death-rate under five years.....	37.80	47.53	63.06	82.10	95.04	111.90	139.52

Diseases) shows the relation between the death-rate per 1000 and density of population in seven groups of districts in England and Wales. What is the most reasonable explanation of such a rapid rise in mortality as people are forced into closer association? Undoubtedly many factors are operative as suggested above, but there is one outstanding factor. Every advance that has been made in our knowledge of communicable diseases during the past twenty years, has emphasized the importance of the infected individual as compared with infected things in the transmission of disease. Intestinal diseases such as typhoid, dysentery and cholera have undoubtedly been spread chiefly by infected water and food. But even in this class of diseases the carrier has always been important, and as pure water supplies and correct sewage disposal become more and more common, the relative importance of the carrier has increased.

In insect borne diseases, density of population is of prime im-

portance. One person to the square mile equals much less than one square meal per mosquito for many mosquitoes would never find him; but 10,000 population per square mile is a regular meal ticket for all mosquitoes. Again, if there is only one person to the square mile, and he is infected with malaria, the mosquito that bites him must fly a mile to bite and infect another person. But if there are ten thousand persons to the square mile, that infected mosquito's chances of obtaining another meal before he dies and so infecting another person are enormously multiplied.

The group of respiratory diseases is a greater factor in mortality than any other group of diseases, including as it does diseases like tuberculosis, pneumonia, measles, diphtheria and many others. With regard to this whole group we have learned that people, not things, are infectious. With the exception of tuberculosis, the organisms responsible for this group of infections have no long life outside the body, and the intermediate transfer of infection by infected articles (fomites) such as clothes, bedding, books, etc. must be rare. Close contact within range of the spray ejected in coughing and sneezing, or shaking hands with one whose hands are soiled by previous use of a handkerchief, kissing, or in the case of children, transferring toys from mouth to mouth seem to be the common methods of infection. The thicker the population, the more frequent are the opportunities for conveying disease in this manner.

The extent to which any of the respiratory diseases may be favored by overcrowding may be seen by a single instance. In 1857 a Royal Commission was instructed to inquire into the conditions of barracks and hospitals in Great Britain. It was found that one-quarter of the Army lived in rooms affording less than 350 cubic feet per man and only 6 per cent had a per capita allowance of 550 cubic feet. The death rate for tuberculosis among such soldiers was much higher than for the civilian population. The commission recommended that 600 cubic feet should be allowed for each man, an improvement that was gradually carried out, and the death rate from tuberculosis fell from 2.78 per 1000 to 0.31 per 1000. Sanitary authorities now believe that a minimum of 720 cubic feet should be allowed each individual,

in order that he may have a proper air space. But for avoiding infection the space allotted to each individual is even more important. The floor space should never be less than 60 square feet, which with a ceiling 12 feet high, affords 720 cubic feet per person. Most of us have far more than this space in our homes, but it is the crowding together in schools, theaters, churches, street cars and similar places that is responsible for the transmission of the organism of so many of the respiratory diseases directly from person to person. Overcrowding in cities may be prevented by proper building regulations, with the elimination of tenement districts and improved traffic rules and facilities.

VENTILATION

Some years ago the effect of overcrowding was ascribed to bad air, and the fatalities occurring in the Black Hole of Calcutta, and the ship *Londonderry* were quoted as illustrations of what excessive crowding would do. The Black Hole of Calcutta was a dungeon 20 feet square with small and obstructed air holes. It was summer when Europeans can only tolerate the heat in large rooms with constantly moving fans. Into this small space one afternoon were crowded 156 prisoners. They trampled each other down and fought for places at the windows. The next morning all but 23 were dead, and the survivors were in such a state that their own mothers would not have known them. (See Macaulay's essay on Lord Clive.)

The *Londonderry* in 1848, left Sligo for Liverpool and running into a storm, 200 steerage passengers were confined over night in a space 18 by 11 by 7 feet with no means of ventilation. In the morning when they were released, over 70 had expired.

Without denying that the air in these cases must have been bad indeed, there is no proof that these victims were killed by bad air. Especially in the case of the Black Hole of Calcutta, where there were two small windows, it would seem that there must have been sufficient oxygen to support life. Indeed if death had been caused by lack of oxygen, there could have been no survivors in either case. All the evidence indicates that these

victims succumbed to the heat. When people are packed together in this way, especially during the hot weather, the free radiation of heat from the body is impeded, the bodily temperature rises and death will ensue unless relief is afforded. All recent work indicates that the effect produced by the air of a badly ventilated room is primarily due to the increase in temperature and humidity, and that these conditions are greatly aggravated by the lack of movement in the air. Decrease in oxygen or the increase in carbon dioxide are not of direct importance. The percentage of oxygen in the worst ventilated rooms is but slightly less than that in the air of the open country, and if temperature and humidity are kept at the proper point, it is possible to work in a room with a proportion of carbon dioxide far in excess of anything usually permitted. We must conclude that the chemical changes in the breathed air of occupied rooms are of minor importance. The most important effects of bad air are due to its high temperature, humidity and stagnation. This kind of atmosphere produces inevitable effects on the heat regulating mechanism of the body. From this it is evident that proper ventilation is just as important as we have always thought in the maintenance of health. It is only our ideas concerning the physiological action of bad air that have undergone any change.

One important practical point may be logically deduced. The important result of proper ventilation is to maintain the body temperature at the correct degree. It follows that people who believe that they must open all their windows in the dead of winter, and spend all night shivering are not obtaining proper ventilation, but on the contrary are reducing their resistance to colds and other respiratory infections by becoming chilled. It is quite healthy for individuals properly equipped with sleeping garments, and having a sufficiently active circulation so that they do not suffer from the cold to open the windows or even sleep outdoors during the winter. On the contrary, individuals that suffer from cold under these circumstances need no longer sacrifice themselves on the supposed altar of Hygeia. Their first duty is to keep warm.

EXERCISE AND FATIGUE

The beneficial effects of proper exercise are so well known that nothing need be said on this point. What does not seem to be so generally recognized is the fact that excessive exercise causing fatigue is injurious. Forty or even twenty-five years ago all hygienic authorities were recommending people to take more exercise. It may have been that people were too sedentary then and needed the advice. At the present time, when many appear to think that if a little will do good, more will do more good, and every magazine is filled with physical culture propaganda calling for vast amounts of time for muscular training, caution against too much exercise appears to be in order. "The great work of the world is not done by men with biceps like Smithfield hams." (*Journal of the American Medical Association.*)

Exercise carried to the point of fatigue does not strengthen, but weakens. Athletes in this condition are said to be "over-trained," and the only remedy is rest. It is true that a young athlete requires more exercise than a sedentary man of fifty. A good working rule is that exercise which leaves a sense of fatigue following a night's rest, has been too severe.

This warning is especially required by men of forty years and over. As young men they have engaged in violent exercise with benefit. At about twenty-five they settle down to business or professional life, with long hours at a desk or other sedentary occupation. At about forty they become alarmed because they are flabby, or because their belt line suggests that their chests have slipped down. They have also by this time perhaps acquired a degree of success which entitles them to a reasonable amount of diversion, and they begin to exercise again. Often they try to play the games they used to enjoy as young men, such as handball, tennis, and other violent exercises. These violent exertions not only cause excessive fatigue, but they are fortunate if they cause no more serious results. The heart muscle grows flabby along with other muscles and is incapable of taking on the added load, and dilatation of the heart is a frequent result of such improper exercises commenced suddenly in later life. A man of

forty will never be the man he was at twenty-five, and he should recognize that fact if he wishes to live a long and useful life. Athletics are for young athletes; for the middle-aged, exercise must be properly limited. A moderate daily walk, a short swim, or a reasonable game of golf is all that is necessary for health. Competitive games are apt to be carried to excess. One set of tennis might be sufficient, but the second and frequently the third set must be played to determine the winner, and one is insensibly urged to greater exertion than was intended. Moderate daily exercise throughout life is the ideal. When for any reason this habit has been interrupted for a number of years, exercise should be resumed very cautiously, gradually increasing the dose until once more a reasonable daily habit is acquired, tapering off with increasing years.

Furthermore, hard and continuous physical exercise is seldom beneficial and is often injurious. Day laborers seldom live to advanced years and seem to be more than usually prone to the degenerative diseases that begin to take their toll after the age of forty. Hard and continuous muscular work is conducive to increased blood pressure, hardening of the arteries, and heart and kidney diseases. In China, coolies who carry heavy loads rarely live beyond forty-five or fifty years. It has been stated that a chair bearer can only work eight years, and a rickshaw runner four years, and that for the rest of his life he is an invalid. Pearl and Hawley have shown by statistical evidence that there is a direct and positive relation between the magnitude of the death from age forty to forty-five on, and the average expenditure of physical energy in occupation. Hard physical labor is associated with high mortality. There is evidence to the effect that the length of life of an animal is in inverse relation to the total work that it performs. The smaller the animal the more rapid is the metabolism and as a general rule the shorter its life. A guinea pig lives longer than a mouse; a dog lives longer than a guinea pig. An automobile is capable of running a certain distance, say two hundred thousand miles; after that the machine is worn out and can only be kept running by constantly replacing parts. It appears that each individual may be similarly limited to a cer-

tain total energy output within its lifetime, and if the energy is expended too rapidly, the life is shortened. Longevity simply depends upon the fact that a type of bodily machine is inherited in which the parts are made of good materials and the machine is therefore capable of producing a larger amount of total energy, and if this energy is not improperly dissipated, will run for a long period.

LIGHT

Light is absolutely necessary to plants since it is only through the action of light on chlorophyll, their green coloring matter, that plants are able to synthesize organic matter from carbon dioxide and water. The action of light on animals is less obvious though its beneficial effect has been observed frequently. Even now the mode of action of light is not completely known, but some things have been learned. The physicists tell us that atoms are composed of a central nucleus carrying a positive electrical charge, with a variable number of electrons bearing negative charges travelling in an orbit about the nucleus. The difference between atoms of the various elements consists in the fact that each has a different number of electrons. Hydrogen, being the simplest element, has only one electron.

Radiation is a phenomenon caused by changes in the position of electrons. When electrons pass from the outer to the inner orbits, radiation is emitted. When radiation is absorbed by an atom, certain electrons are removed from the inner to the outer orbits. Light consists of certain radiations, transmitted in waves, and differs in kind according to wave length. The Hertzian waves used in radio have wave lengths varying from hundreds of meters long, to 60,000 micromillimeters, where the infra-red or heat rays commence. A micromillimeter is one millionth part of a millimeter, which in turn is a thousandth part of a meter. Wave lengths from 60,000 to 760 micromillimeters are heat rays.

The visible rays have wave lengths varying from 760 to 400 micromillimeters, and within this range we have the colors of the spectrum, red, orange, yellow, green, blue and violet. Beyond the violet are the ultraviolet rays having wave lengths varying

between 400 and 180 micromillimeters. These ultraviolet rays excite no sense organs and we are as unconscious of them as we are of the Hertzian waves at the other end. But their existence can be proved by the effect they produce upon a fluorescent screen or a photographic plate. Beyond the shortest ultraviolet rays come the softest Roentgen rays. These merge into hard Roentgen rays and these latter into the gamma rays of radium with wave lengths of only 0.01 micromillimeter.

To produce any action on the body, rays must be absorbed. Light rays are absorbed by the retina and produce vision. They apparently have no other physiological effect. The ultraviolet rays are absorbed by the skin. The shortest ultraviolet rays are absorbed by the horny layer of the skin and have little if any effect, but the ultraviolet rays between wave lengths of 320 to 240 pass through the epidermis and are absorbed by the deeper living layers of the skin, where in sufficient quantity they produce the condition known as sunburn. This burn is caused because in the process of absorption, the rays knock electrons off the atoms and thereby alter the electrical reaction of the molecules of protoplasm in the cell. This causes chemical changes in the protoplasm resulting in irritation or even death of the cells and what we recognize as a burn. This burn is caused by excessive radiation. Ordinary exposures cause only a local stimulation which produces in some reflex manner an increase in metabolism. That is we live on a higher plane, absorbing more oxygen, eliminating more carbon dioxide and nitrogenous excretory matters and using more food. In addition to all this it has been shown that as the result of the action of these rays, the general immunity is increased.

The longer ultraviolet rays pass through the skin to be absorbed by the blood. These rays probably have a physiologic effect, though we do not know precisely how they affect the body. But at least it is known that ultraviolet light exerts a peculiar influence upon the metabolism of calcium and phosphorus. It is the disturbance of this metabolism in children that produces rickets, and ultraviolet light is one of the curative and preventive factors in this disease. The ultraviolet rays are also the part of the light waves that are responsible for killing bacteria. Bacteria are

killed in thirty minutes by exposure to ultraviolet rays of 275 micromillimeters wave length, and in three minutes by rays of 232 micromillimeters wave length. It has been known ever since bacterial cultures were first grown that they were killed by direct sunlight and throve best in the dark. Ultraviolet radiations are so powerful in this respect that they have been used to sterilize water which flows slowly past a mercury vapor lamp enclosed in a quartz box, which is producing these rays.

The hygienic importance of these observations cannot be overestimated. They show why it is unhealthy to live in dark rooms. Not only do we lose the health-giving properties of the ultraviolet rays, but such bacteria as the bacillus of tuberculosis can live indefinitely in such dark places. Bright sunlight is one of the best disinfectants known, and clothes and other articles hung out in the direct rays of the sun can be sterilized in this way. Glass absorbs those ultraviolet rays having the shorter wave lengths, and therefore in the house we lose this part of ultraviolet light. It has been known for a long time that indoor gymnasium exercise was not so beneficial as exercise or games out of doors. The explanation is now apparent. Not only are outdoor sports more interesting, but we obtain the beneficial effect of the ultraviolet light.

Physicians are now treating tuberculosis, rickets, and certain skin diseases by graded doses of ultraviolet light, given preferably by properly controlled sun baths once or twice a week, or by special lamps producing ultraviolet rays when sun baths are not applicable.

One attack of sunburn will convince any one that it is possible to have too much of a good thing. Ultraviolet light used in excess or in unsuitable cases produces depression instead of stimulation and it is obvious that the medical use of such light requires training and judgment. But we may all profit from what has been learned about ultraviolet light, increasing our general health and resistance to infection by spending a reasonable part of our time out in the sunlight. Exercise taken for health should whenever possible be outdoors. We must also endeavor to get rid of smoke pollution which cuts off the light, and on suitable occa-

sions expose more of our skin to the light. We all do this at the seashore, and this may explain largely the benefit derived from such a vacation. At other times of the year the women have the advantage of the men in the matter of exposing a greater area of skin. Perhaps these abbreviated costumes are not altogether a question of taste (or form) and the women have all the time been wearing the most sensible clothes. This is a painful thought for the male mind and we need not prolong the agony.

BATHING

Bathing is chiefly dictated by aesthetic considerations, and is not as essential to health as is generally supposed. Many people who never bathe enjoy robust health. Nevertheless frequent bathing has a certain sanitary significance. The surfaces of the body protect it from the invasion of bacteria, but certain bacteria, especially the staphylococci that produce boils are capable of penetrating the unbroken skin. The space around each hair is large as compared with these microörganisms and infection by the route of the hair follicles is common When the bodily resistance is lowered in any way, a crop of boils is the result. Mechanical cleansing of the skin by bathing has the effect of washing off these microörganisms and preventing infection. The frequent washing of the hands is an even more effective means of escaping infection. The fingers may be soiled with many organisms producing intestinal diseases such as typhoid or dysentery, or the eggs of intestinal parasites. Children often keep themselves infested with certain varieties of intestinal worms, particularly the pin worm (*Oxyuris vermicularis*) by scratching themselves and afterward putting the fingers in the mouth. Many of the respiratory infections are undoubtedly transmitted in this way. The fingers are frequently brought in contact with the mouth and nose, and if infection is present it is conveyed to all objects and people subsequently touched. We shake hands with a man having a cold and then roll a cigarette or lick a postage stamp, and wonder how we contracted the cold. The methods of direct or indirect contact with infection are infinite and many infectious diseases are conveyed in this way. The obvious

remedy is to form the habit of keeping the fingers away from the nose and mouth as much as possible, and to wash the hands frequently, and especially after leaving the toilet, before meals, and whenever the hands are known to be soiled with possibly infectious material. This should be established as a habit so that it is done without thought just as we brush our teeth automatically. Nothing is more wearing than to be forever thinking about possible infection and means to avoid it. Indeed some people become so fussy on this subject that they are victims of a form of monomania, known as bacteriophobia, and their life ceases to be worth living. There is a happy medium between complete indifference to all sanitary precautions and slavish devotion to a hygienic ritual. Habits of cleanliness should be taught to children, and the good effects then persist throughout life without thinking of the sanitary reason for such acts.

Finally, there are a number of factors that influence health that are well known but whose influence is so vague that they can hardly be explained. Marriage is such an influence. It is not true that married life only seems longer. Married men live longer than bachelors. In Scotland where statistics for this condition have been compiled, the bachelor of twenty-five, if he remains single, has an expectation of life five years less than if he married. These figures may be influenced to some extent by the fact that men in bad health do not marry. But undoubtedly also, marriage conduces to a more regular life, better food, and a disposition to avoid unnecessary risks. Married women live on an average six months longer than spinsters, and this in spite of the added risk that married women undergo in pregnancy and childbirth. Married life is more nearly normal than celibacy, and over a period of years is a small but definite asset in the maintenance of health and the avoidance of infection.

REFERENCES

(1) Conklin, Edwin G.: Heredity and Environment. Princeton University Press, 1922.
(2) McVail: The Preventiou of Infectious Diseases. Macmillan & Co., 1907.
(3) Whipple: Vital Statistics. John Wiley & Sons, 1923.
(4) Abbott, A. C.: The Hygiene of Transmissible Diseases, 2nd ed. W. B. Saunders & Company, 1901.
(5) Pearl: Studies in Human Biology (Chapter XI). The Williams & Wilkins Co., Baltimore, 1924.

CHAPTER II

Infectious Diseases

In discussing the cause of the various infectious diseases, some classification is necessary. No classification is strictly accurate or includes every disease. The parasites causing disease include worms, protozoa, bacteria and fungi. As a general rule, worms are inhabitants of the digestive tract, but the filaria is a blood worm carried by mosquitoes and the *Trichina spiralis* lives in the muscle fibres. Most protozoal parasites are carried by insects, but amoebic dysentery is an intestinal disease and is conveyed from patient to patient like other intestinal infections. Most bacteria are conveyed from person to person, but plague is an insect-borne disease transmitted from the rat to man by the flea.

For the prevention of disease it is even more important to understand the methods whereby infection is transmitted from one person to another than to recognize the infective agent. Thus the infective agent of leprosy (*B. leprae*) has been known for some time, but the method of its transfer from person to person is not known, and endeavors to check the spread of leprosy have not been completely successful. Therefore, from the sanitary point of view, infectious diseases may be classified according to their usual method of spread as:

1. Intestinal—spread chiefly by faecal contamination.
2. Respiratory—spread by secretions from the mouth and nose.
3. Insect-borne—infection transmitted by some biting insect.
4. Animal—conveyed to man directly from some other animal.
5. Skin infections—spread through unbroken skin, or slight wounds.
6. Venereal—spread chiefly by sexual contact.

INTESTINAL DISEASES

The most important of these diseases are typhoid fever, cholera, the dysenteries, and diarrhoeal diseases.

Typhoid fever

Typhoid fever is a disease characterized by severe intoxication, a continuous fever lasting from three to five weeks, and especially by enlargement of the spleen and ulcerations in the small intestine. Haemorrhage occurs from these ulcers when a blood vessel is eroded, and perforation of the intestine may occur resulting in general peritonitis and death if the perforation is not promptly closed by surgical interference. It is a serious disease, not only because of its mortality, which is relatively small in well-treated cases, but because like the poor, we have it always with us, and because of the long disability that it produces.

The cause of typhoid fever is the *Bacillus typhosus*. This bacillus, taken in the intestine, invades the blood during the first week of the disease, is carried to various organs causing swelling of the spleen and inflammation and ulceration of the lymphoid structure of the intestine (Peyer's patches). Later the bacilli are discharged in enormous numbers in the stools and often the urine of patients.

Method of transmission. The bacilli from the excreta of a previous case must be swallowed. Typhoid fever is therefore a filth disease, is totally unnecessary and may be prevented. The organisms are most often transmitted through water, but they may be in milk, or other infected food, particularly if eaten raw. In other cases, the organisms are acquired by direct contact with a case of the disease or with a carrier. These methods of transfer are well known and controlled wherever there is an efficient sanitary service. Each case of typhoid is investigated to determine the source of infection, after which the proper methods are taken to prevent further infections from this source.

In order to prevent water-borne typhoid, the excreta from each case should be carefully disinfected prior to disposal. This depends upon early diagnosis of each case, and removal to hospital

except in the case of well-to-do patients who can employ a competent nurse. But while emphasizing this measure, we know that it will not be adequately performed in all cases. The only certain way to prevent water-borne typhoid is to provide a proper system of sewage disposal and a water supply that cannot be contaminated.

Water. In country districts wells are often contaminated by seepage from nearby cesspools. If the excreta from a case of typhoid fever are thrown into such a cesspool, the people who drink the well water are liable to infection. Such subterranean seepage may be demonstrated by pouring a dye known as fluorescein into the cesspool, and observing its presence in the well water later. This dye is of such an intense color that one part in ten million parts of water is obvious. This investigation is usually suggested by the occurrence of several cases of typhoid in the house using the contaminated water. Numbers of city people who go into the country for the summer are infected in this way, and it is a good rule for all vacationists to take the antityphoid inoculation several weeks before going away for the summer, if they have not received this protection within three years.

Even good water supply systems may be infected by carelessness in the disposal of the excreta of typhoid patients, in which case an epidemic of typhoid may result. There are many such instances in the literature, but a single example must suffice. The town of Plymouth, Pennsylvania, in 1885, was supplied with piped water from several reservoirs. A man living about 40 feet from the banks of the stream supplying these reservoirs, went to Philadelphia on December 25, 1884, and contracted typhoid fever. He returned to his home where he was sick for the usual period of the disease. While ill, the excreta passed during the night were deposited on the snow behind the house. On March 21, there was a thaw which melted the snow for the first time that winter and the entire quantity of dejecta passed by the patient during his illness was washed into the stream. Typhoid fever appeared in the town of Plymouth about two weeks later (the usual incubation period for typhoid, which may be

from eight to twenty days) and from 60 to 100 new cases were reported daily. Out of a town of 9000 inhabitants at least 1000 developed typhoid at this time. The facts in this case were well established by a careful investigation conducted later. Only those were infected in this instance who drank the city water. An effort is now made to prevent such gross infection of water supplies by impounding the areas from which city water originates, and constant sanitary supervision of those areas.

The city of Philadelphia for many years had an adequate sewer system, but used water from the Schuylkill River into which the sewage from towns further up the river was poured. Typhoid fever was always present and at times in epidemic proportions. But as soon as the city established a proper filtration system, most of this typhoid disappeared. Nearly all cities of any size now supply filtered or chlorinated water, and water-borne typhoid in such cities has been eliminated. Even small towns can afford a chlorinating system and water so chlorinated is perfectly safe. If the water does not contain a large percentage of organic matter, two-tenths of a part of liquid chlorine per million parts of water is sufficient to render the water practically sterile. Apparatus that chlorinates water automatically is now on the market and is relatively cheap so that there is no longer any excuse for water-borne typhoid in any city or town having a regular water supply.

Milk is another frequent source of typhoid infection. This happens when the milk is handled by a person in the early stages of typhoid or by a typhoid carrier, or when milk cans are washed with infected water. In 1907, Rosenau had recorded 317 outbreaks of typhoid fever transmitted by infected raw milk. In many large cities all food handlers are examined periodically to prevent this sort of thing from happening, although no such examination can be a complete guarantee. But pasteurization kills the typhoid organism. In pasteurization milk is heated to 145°F. for half an hour after which the milk is rapidly cooled. In Chicago there has been no case of typhoid or other infectious disease traced to the milk supply since 1916, when the universal pasteurization was put into effect. This pasteurization is checked by the health department by making bacterial counts of the milk

before and after pasteurization and it is required that the pasteurization machines be equipped with automatic temperature recording devices, the records of which are submitted to the health department every week. The bottles are sterilized and hand capping of the bottles is prohibited. By such methods, milk-borne typhoid has been eliminated from most large cities, so that so far as typhoid fever is concerned, the city dweller is highly favored as compared with his country cousin.

Oysters. Oysters are brought in from the oyster beds to be "fattened" or "plumped." For this purpose they are left on floats. If such a float is located near the outlet of a sewer, the oysters take up and retain typhoid bacilli, if present in the sewage. There are at least fifteen outbreaks of typhoid in the literature directly connected with the eating of raw oysters. Since few wish to abjure entirely this luscious bivalve, the only remedy consists of sanitary supervision of the oyster industry. Attention was focussed on this point as the result of disastrous outbreaks of typhoid occurring in New York and Chicago several years ago, in which the disease was directly traced to certain oyster beds near New York, and sanitary supervision of this industry was then established.

Contact with cases. Nurses and members of the family caring for typhoid patients are apt to become infected. The infection may be readily acquired while emptying bedpads and urinals, or from handling soiled bedding or through giving baths. The hands should be washed and disinfected after performing any such act.

Typhoid cases are apt to be up and about during the first few days of their illness. More than that some cases never are so sick as to be compelled to go to bed, although they feel miserable. Such cases have been called "walking typhoid" and may be discharging just as many typhoid bacilli as a case confined to bed. By the very fact that they mingle freely with members of the community, they are far more dangerous than cases confined to bed. Should their hands be soiled with infectious material, they can convey the disease from person to person by the simple act of shaking hands. This personal contact with early or "missed

cases" was a common source of infection among the soldiers in the Spanish-American War. A board studied these cases, and showed that of 1608 cases studied, 35 per cent were directly connectable and 27.8 per cent more were indirectly connectable, so that nearly 63 per cent of the cases were spread by contact. This high percentage of contact infection was caused primarily by insanitary methods of disposal and lack of facilities for washing, and secondarily by the close association necessary in a military camp. Such conditions do not occur ordinarily in civil life and contact infection is relatively rare. Nevertheless, it is always one possible method of infection, since early cases or mild cases and carriers may be at large at any time. The elimination of this source of infection depends upon the recognition and control of early and "missed cases." This would be facilitated if everyone having a fever would call a physician at once.

Flies. The common house fly is at times a conveyer of typhoid. The house fly is a filthy insect, feeding upon excreta and habitually laying its eggs in manure or human excreta. These insects fly from the open privy to the table and walk over bread, sugar and often fall into milk. It has been shown experimentally that typhoid bacteria may adhere to the legs of flies for various periods of time up to twenty-three days, and that these and other bacteria, as well as the eggs of intestinal parasites, may pass through the intestinal tract of the fly and be deposited in an infectious condition in the excreta of the fly (fly specks). The mouth parts of the house fly are fused into a proboscis so that it cannot bite or eat solid matter. It obtains solid matter such as sugar by regurgitating droplets from its stomach upon the food and then sucking them back after this fluid has dissolved some of the food. Disease organisms present in the stomach of the fly may also be deposited upon the food in this way. In our cities where sewage disposal is satisfactory, flies can seldom become infected, but in rural districts or in a military camp, with a single case of typhoid introduced, the fly is a frequent transmitter of infection. Aesthetic considerations alone are sufficient to condemn the fly, and fly-swatting campaigns are now pretty general. But it would be better and easier to prevent his development than to swat him.

Flies breed in any decaying organic matter, but under ordinary circumstances 95 per cent of flies originate from horse manure. The eggs of the housefly hatch in from twelve to twenty-four hours, and the larva or maggot grows rapidly for from four to six days. It then goes into a resting stage (pupa) during which the transformation to the adult fly occurs. In warm weather the time from the laying of the egg to the emergence of the adult fly is ten to fourteen days. From this it is readily seen how a single small manure pile may give rise to a perfect pest of flies. If manure were kept in screened bins, flies could not reach it. With the partial disappearance of the horse from cities, flies have become less common. In country districts where manure must be kept for fertilizer, and it is highly improbable that it will be kept under proper conditions for many years to come, houses should be screened, and the few flies that enter should be killed by swatting, poisons or sticky fly paper. Those valuing health or comfort should not go to spend the summer at a farm with an unscreened house, an outside privy and a nearby manure pile to furnish an unlimited supply of filthy flies.

Carriers. Nearly everyone has heard of "Typhoid Mary," the cook who infected family after family with typhoid fever over a period of years before it was learned that she was a carrier. There are references in the literature to over three hundred experiences with typhoid carriers. A carrier has been defined as an individual who harbors and transmits disease organisms without showing the usual evidences of infection, (Nichols.) This definition includes early and undiagnosed or "missed" cases and mechanical carriers. But the real carriers here discussed are healthy people who have recovered from an attack of typhoid fever but still continue to carry the organism and spread infection. Such carriers are the reservoirs of infection and at present are the commonest source of infection. Typhoid cases are recognized, are limited to a few weeks, are confined to bed and rarely transmit infection when they have proper nursing. The carriers may harbor the infection for months or years, are healthy and active, and until detected pass freely in the community and may be cooks or dairy operatives. About 3 per cent of typhoid cases become

carriers so that it has been estimated from the total number of cases of typhoid fever that 7500 intestinal carriers are added yearly to the population of the United States. This cannot be cumulative because a certain number of these carriers lose their infection each year. The Army has made a practice of examining all food handlers for a number of years, and from such examinations it is believed that among healthy males, the number of typhoid carriers is under one to one thousand.

So far as typhoid fever is concerned, the usual cause of the carrier state is a chronic infection of the gall bladder. No method has yet been found of ridding a typhoid carrier of his infection except removal of the gall bladder by a surgical operation. A man can live and function perfectly well without a gall bladder, but we cannot compel healthy people to submit to such an operation. All that we can do at present in such cases is to prohibit them from handling any food, and teach them certain rules of life. The directions for a typhoid carrier are as follows:

1. Deposit faeces and urine only in places where they cannot infect a water supply.
2. Wash hands after going to toilet. Have an individual towel.
3. Wash hands before each meal.
4. Do not use a bath tub. Use a shower.
5. Disinfect soiled underclothing in a 5 per cent carbolic solution.
6. Do not enter a food handling occupation.

The first four of the above rules are good hygienic rules for everyone.

After an attack of typhoid fever the patient should not be released until bacteriologic examination of faeces and urine have been negative for typhoid on three successive examinations. If still carying typhoid bacilli after complete recovery, such patients cannot be confined, but at least are known, can be properly instructed in the above rules, and can be watched by the health department to prevent them from entering any food handling occupation. This is especially necessary in the case of women who are so apt to be cooks.

Antityphoid vaccination. It is apparent from the above dis-

cussion, that although proper sanitary precautions are capable of greatly reducing the incidence of typhoid fever, and indeed have already done so, yet from the nature of the case, typhoid fever can never be completely eradicated by sanitary measures alone. It might be possible to do so if every one were perfect. But the millenium has not yet arrived, and many people still care little for their neighbors as compared with their own pleasure or profit, and many people are yet too ignorant of sanitary rules or of the reason for them. What then remains? Must we always have an irreducible minimum of typhoid fever, or can it be completely eradicated? The United States Army has afforded the answer to this question. Antityphoid vaccination did not originate in the

TABLE 2

Statistics concerning antityphoid vaccination from the annual reports of the Surgeon-General of the United States Army

YEAR	ADMISSION RATES FOR TYPHOID PER 1000	YEAR	ADMISSION RATES FOR TYPHOID PER 1000
1905	3.14	1911†	0.85
1906	5.72	1912	0.31
1907	3.79	1913	0.04
1908	3.20	1914	0.07
1909*	3.25	1915	0.08
1910	2.43	1916	0.03

* Voluntary vaccination commenced.
† Compulsory vaccination commenced.

United States Army. It was used by both the Germans and by the British Army in the Boer War with excellent results. But the United States Army was the first large body of men in which antityphoid vaccination was made universal. Laboratory studies were commenced in 1903 for the purpose of determining the best method of preparing an antityphoid vaccine, and these studies have been pursued continuously. By 1909 sufficient information had been acquired by experimentation on animals to justify voluntary vaccination of men, and officers and soldiers were advised to take this prophylactic. After 20,000 such voluntary vaccinations had demonstrated the harmlessness of the method, this vaccination was made compulsory for all troops

serving on the Mexican border in March, 1911. In June, 1911, antityphoid vaccination was given to all recruits, and in September, 1911, compulsory vaccination was extended to all persons in the military service, under forty-five years of age. This measure has been in force continuously since that date, and as a result typhoid fever has been practically eradicated from the Army. The figures in table 2 have been taken from the annual reports of the Surgeon-General of the Army.

The years of 1917 and 1918 were war years, during which 4,000,000 men were mobilized in camps, and about half of them served in France under war conditions. In 1917, there were 297 cases of typhoid fever and twenty cases of paratyphoid fever (a condition clinically like typhoid fever but caused by a different organism (*Bacillus paratyphosus*)). In 1898, during the Spanish War, the admission rate for typhoid was 141 per 1000 men, and the death rate was 14 per 1000.[1] If this experience had been repeated during the World War, there would have been 140,000 cases and 14,000 deaths for each million men, or approximately 560,000 cases and 56,000 deaths. To be sure, sanitary conditions in 1917 were much better than in 1898, but they were far from perfect. Sanitation can never be even approximately perfect among armies in the field, for armies are not levied for the purpose of staging a demonstration of sanitary methods, but to defeat the enemy. There are many occasions when military exigency demands the sacrifice not only of comfort but of sanitary considerations in order that its main purpose may be effected, and a certain amount of disease and death must be expected. One cannot have an omelet without breaking eggs. Therefore, it is certain that had the troops in 1917 not been protected by the antityphoid inoculation, there would have been an enormous amount of typhoid fever even though sanitary conditions were somewhat better than in 1898. The fact that there were only about three hundred cases of typhoid fever among these millioms of men, living in abnormal conditions in crowded camps is a triumph of preventive medicine, and proves the great effectiveness

[1] From April 1917–December 1919, the mean annual strength of the army was 4,128,479, and there were 1,529 cases of typhoid or a rate of 0.37 per 1000.

of antityphoid vaccination in preventing typhoid fever. The United States Navy has had a precisely similar experience.

It is impossible to make such a method compulsory in civil life, but with such facts at hand, it is a wonder that everyone does not raise a clamor for this protection. Boards of health in most communities would be only too happy to provide this treatment free of charge, or at a merely nominal charge to cover the cost of the service. A certain proportion of the population have indeed already taken advantage of this opportunity and more will undoubtedly follow as the facts become more generally known. Should this method be generally followed, it is highly probable that in a generation, typhoid fever would become practically unknown.

There is a small minority of people who are persistently opposed to vaccination against smallpox, and typhoid, the use of diphtheria antitoxin and all such methods of disease prevention and treatment. Since the minds of such people are completely closed to facts and they are entirely governed by prejudice, it is a hopeless task to attempt to convince them. But the main reason deterring most people from availing themselves of the advantage of this protection is fear of bad results. A physician often hears people state that some disease or ill health has been caused as the result of typhoid inoculation. Although in a few instances such disease has followed the inoculation, it cannot be stated too emphatically that it is merely a coincidence and cannot be caused by the inoculation itself. Such people would have suffered from the disease in question just the same had they not received the treatment. It is self evident that out of thousands of people, a certain proportion of them will become sick in the course of the next two weeks, and they will become sick whether or no they happen to be vaccinated or take the antityphoid inoculation. The experience of the Army and Navy in vaccinating millions of men has proved completely the harmlessness of the procedure.

The typhoid vaccine is simply a suspension of killed typhoid bacilli together with their soluble products. The bacteria are first killed by heat, and subsequently a sufficient amount of tricresol (a substance more actively germicidal than carbolic

acid) is added to the suspension to kill not only typhoid bacilli but any variety of bacteria. The sterility of every batch of vaccine is proven by cultures, and its harmlessness proven by animal inoculation before the vaccine is released for use. The vaccine used at present contains 1000 million dead typhoid bacilli in each cubic centimeter, and also a lesser number of two paratyphoid bacteria. The vaccine is given in three doses at a week to ten days' interval so that the course requires about two weeks. The vaccine is injected subcutaneously by a hypodermic syringe and causes no pain other than a momentary smarting caused by the preservative. Within the next few hours there is some redness and swelling immediately around the site of the inoculation, and the arm feels sore. This redness and soreness passes off in two or three days. The general symptoms may be absent, mild or severe, and consist of headache, a general feeling of malaise, and a rise in temperature. In severe cases this fever may reach 104°, but fortunately such cases are the exception. It is rarely necessary to go to bed. Most soldiers do not even find it necessary to be excused from their duties. The inoculations are best given at from four to five o'clock in the afternoon, so that the majority of the discomfort is over by the next morning. In even severe cases, the symptoms disappear entirely in two or three days. Children two years of age, and over, bear the inoculation better than adults and seldom feel any ill effects aside from slight redness and soreness of the arm.

The inoculation should be repeated at three to four year intervals. The immunity produced undoubtedly lasts in diminishing amount for a number of years. The soldier enlists for three years, and we know that one course of treatment given when he is a recruit protects him for his entire enlistment. How much longer protection may last, we cannot say, so the treatment should be repeated at about this length of time.

No one suffering from an acute illness or from chronic disease of the kidneys should receive the inoculation, although it has no harmful effect on the progress of tuberculosis. It is harmless in normal people. Surely the definite protection secured is well worth the slight expenditure of energy and trouble and the slight inconvenience following it, preventing, as it does, a disease that

lasts a month as a rule, and causes an enormous expense and economic loss.

Cholera

This disease is caused by the *Spirillum cholerae*, a small comma-shaped bacillus. This organism is present in enormous numbers in the bowel evacuations and vomited matter from cases of cholera, and the disease can only be acquired by swallowing these organisms from a previous case. Cholera is chiefly transmitted through infected water or foods that are eaten raw, though it may also be transmitted by contact with carriers and by flies. The methods of transmission are therefore precisely those of typhoid fever.

About 3 per cent of cases of cholera become carriers after convalescence. The gall bladder becomes infected and the organisms of cholera are excreted in the stools. In countries where cholera is endemic, these carriers serve as a reservoir of infection and carry the disease over from one season to another. Cholera always begins with the rains which wash this infected material into small streams where the natives fish, bathe and wash clothes. Each case so infected may infect several more at widely separated points, and so the epidemic begins with cases of cholera appearing at a number of points simultaneously. Until the rôle of the carrier was known, this tendency for cholera to appear explosively soon after the beginning of the rains, could not be explained.

Cholera has always been present in India and certain other oriental countries, and from these countries it was formerly introduced into Europe and the United States so that disastrous epidemics have occurred in countries like England, Germany, and the United States. Cholera first appeared in the United States in 1832, and there were eight epidemics during succeeding years, the last occurring in 1873. There was a severe epidemic of cholera in Germany as late as 1892. In more recent years cholera has been unable to gain a foothold in these countries. Although a pure water supply and proper disposal of sewage greatly reduce the liability to cholera, this alone is not the reason

for the exclusion of this disease from countries like the United States, because typhoid fever, a disease spread by precisely the same methods, still persists. The source of protection in this case is quarantine.

Cholera is so acute a disease that it cannot occur on a ship without detection by the ship's surgeon. It is further a disease having a very short incubation period, almost invariably less than five days. When a ship arrives at a port it is boarded by the quarantine officer, who in the United States is usually an officer of the United States Public Health Service, and who has information of all quarantinable diseases occurring in the ports touched by the ship in question. Should cholera have occurred on the ship during the voyage, the ship is placed in quarantine, and no one is permitted to land until the ship has been free from the disease for five days. Even then bacteriological examinations are made in order to detect carriers. By carrying out these measures it is possible to prevent completely the introduction of the disease in a country once free from it.

Since this procedure causes great inconvenience to both the passengers and to the ship, all first class steamships take the greatest precautions to avoid having this disease. When such a ship sails from an infected port, all steerage passengers are compelled to remain in quarantine to be certain that they are free from the disease before they are permitted to board the ship, and the ship's surgeon satisfies himself that the first-class passengers and crew are also free from the disease. With these measures in force it has become very rare for a ship entering the United States to be detained because of the occurrence of cholera.

When cholera is present it can be avoided by drinking only boiled water, avoiding all raw foods, and protecting food from flies. Thus, in the Philippines where cholera formerly occurred to a greater or less extent nearly every year, Americans and Europeans who followed these simple precautions almost never contracted the disease.

An inoculation against cholera is also available consisting of a saline suspension of killed cholera organisms, which is injected subcutaneously. This inoculation or vaccine, as it is called,

confers a high degree of immunity for probably as long as six months, and causes even less inconvenience than the typhoid vaccine. A rather extensive epidemic of cholera occurring among the Filipinos during the year 1925 was apparently controlled by this method alone, namely, vaccination of all natives wherever the disease appeared. All military personnel were required to take this inoculation and no case of cholera occurred in this group. Cases of cholera did occur in the families of certain of the Filipino Scouts who had not been vaccinated. The Scouts themselves who were vaccinated had no cases.

Cholera is a disease having a high mortality (50 to 80 per cent), that occurs suddenly and usually kills within twenty-four hours, and which rapidly takes on epidemic proportions. It is easy to imagine the terror and dislocation of all usual business which such an epidemic used to inspire. As the result of scientific information which has been acquired since 1880, we have means at our disposal to prevent such epidemics completely even in countries where the disease is endemic (constantly present) to prevent its introduction into countries now free from it, and to avoid the disease even while living in a country where it is endemic. It seems probable that the disease could be completely eradicated if Oriental races that now serve as foci for the distribution of the disease, could be induced to submit to universal annual cholera vaccination for a few years. At present this appears quite improbable, but in view of what has been done in the past fifty years, who can foretell what the next fifty years will bring forth?

Dysentery

Dysentery is popularly known as "bloody flux." There are two forms, the acute and chronic. The acute type is caused by the bacillus of dysentery which is transmitted from patient to patient by the same methods as typhoid fever and cholera except that carriers are less frequent. The gall bladder is not infected, and carriers result from an intestinal ulcer that fails to heal. The carrier condition therefore does not occur so frequently or last so long as when the gall bladder becomes infected.

Chronic dysentery is caused by infection by a species of amoeba

called the *Entamoeba dysenteriae*. This organism burrows into the mucous membrane of the large intestine and forms ulcers. A frequent complication of this disease is abscess of the liver. The reproductive cycle of this amoeba consists of cysts which are very resistant and passing out with the stools serve to convey the infection to others who may swallow them in infected water or food. Although emetine is a specific for this disease, a long period of treatment is required to effect a cure, and the greatest source of infection are the people who have apparently recovered as the result of a short course of treatment, but who still harbor the parasite in unhealed ulcers and continue to pass it in the stools. The disease may be avoided by using the same precautions as for cholera or typhoid, namely, a pure water supply and the avoidance or sterilization of uncooked foods. Fruits and vegetables to be eaten raw may be sterilized by immersing them in boiling water for about fifteen seconds.

Although both types of dysentery are more frequent in tropical countries, they are by no means infrequent in the United States. The trained physician can recognize the disease and the type by a microscopic examination of the stools. Acute bacillary dysentery may be recognized by the type of cells in the exudate which are chiefly pus cells, red blood cells, and a large cell called a macrophage, which functions as a scavenger of bacteria and dead cells. In chronic or amoebic dysentery the cells are different and the amoeba is readily found and identified. If the disease is bacillary, the injection of antidysenteric serum produces excellent results when given early in the disease. Later it is not of such great value. This serum is prepared by immunizing horses to a number of different varieties of dysentery bacilli. When the disease is chronic, or amoebic, the hypodermic injection of emetine gives prompt relief so that all symptoms of the disease may disappear in several days. But, as previously stated, a long period of observation and treatment must follow this apparent cure, otherwise relapses will occur and the patient remains capable of transmitting the infection.

Diarrhoea

This is a condition resulting from a multiplicity of causes. In some cases it seems probable that it may be caused by simply chilling of the body, overeating, or the consumption of an improper diet. In other cases it is the result of various bacterial infections of the food. There are many bacteria that cause no specific disease, but when they have multiplied in foodstuffs, which may or may not appear spoiled, are capable of producing diarrhoea. The distinction between such a form of diarrhoea and so-called "food poisoning" is arbitrary. The term food poisoning is generally used to include the more serious infections of this type, which usually cause other manifestations of disease in addition to diarrhoea. Whatever the original cause, the production of diarrhoea occurs according to a simple mechanism, This is a reduction in the activity of the digestive fluids, and consequently an accumulation of a residue of undigested food in the intestine. Bacterial decomposition of this food follows rapidly with the formation of irritating products that stimulate the intestine to increased movement and frequent bowel evacuations. The diarrhoea of infants or "summer complaint" is caused in this manner usually from the consumption of infected milk. Milk containing a large number of bacteria is unsuitable as food for infants even when none of these bacteria are disease-producing organisms. Milk, if used raw for infants, should not contain more than 50,000 bacteria per cubic centimeter, and if pasteurized should not contain more than 200,000 bacteria before pasteurization and not more than 30,000 after pasteurization.

Pasteurization of all milk for infants is highly desirable, and the use of this method by many cities has resulted in a great reduction of the infantile mortality from diarrhoeal diseases, and from other diseases such as tuberculosis, diphtheria, and scarlet fever, which are occasionally transmitted in the milk, as well. Nevertheless, even when pasteurization is employed, the milk should be comparatively free from bacteria to start with. Milk containing millions of bacteria per cubic centimeter may,

after pasteurization, be used as food for adults if they wish their stomachs to serve as bacterial graveyards. But under no circumstances is such a preparation of barbecued bacteria suitable as food for infants. Infant health, particularly in the summer, is closely associated with the use of pure milk from healthy tuberculin tested cows, collected in properly conducted and inspected stables, pasteurized, and subsequently iced, and used promptly to prevent development of bacteria after pasteurization.

Food poisoning

There are several varieties of food poisoning caused by infection of the food. One of the commonest forms occurs from eating hash or meat cakes that have been prepared the day before and not cooked until the next morning. Potatoes and onions commonly carry certain bacteria, and when these vegetables are mixed with meat and allowed to stand, some of these organisms grow on the meat and produce a toxin. Subsequent cooking does not destroy this toxin, and when such hash is eaten those consuming it are affected by severe diarrhoea, vomiting, fever, and general prostration. This form of food poisoning while very troublesome, is rarely fatal.

A much more serious form of food poisoning occurs when meat is infected by the *Bacillus enteritidis*, the *Paratyphosus B.*, and similar organisms belonging to what is now known as the Salmonella group of bacteria. These organisms also produce a toxin, and the symptoms produced are similar to those just described, but are more severe, and death from this form of food poisoning may occur. Most of the cases that in former times were called "ptomaine poisoning" belong in this group. Such food poisoning may be avoided by using unusual care in the handling, icing and preparation of meat and meat products, and prompt cooking and consumption after they have left the refrigerator.

Botulism

This most serious of all forms of food poisoning is caused by the consumption of canned foods containing the *Bacillus botulinus*. This is a spore-bearing organism, capable of resisting considerable

heat, and occurring in nature in the soil. It is more apt to be present in home canned vegetables which usually are not subjected to much heat, than in cans that are sold and which have been properly sterilized by exposure to temperatures higher than boiling. The organism is anaerobic or grows only in the absence of oxygen, a condition obtaining in canned goods. If this organism is present in such canned vegetables that are not sterilized, it grows and produces a toxin. This poison has a special affinity for the nervous system, and causes death by paralysis of the respiratory center of the brain. It also causes paralysis of the nerves controlling the eye muscles resulting in double vision and paralysis of the nervous mechanism producing swallowing, so that the first symptoms of this form of food poisoning are double vision and inability to swallow. This poison is usually destroyed by thorough cooking, and this form of poisoning has accordingly been associated with articles of food that are consumed raw, such as canned asparagus and ripe olives, or with vegetables that are cooked very little such as canned spinach. A number of such cases of food poisoning have been reported in recent years, some of them resulting in many deaths. Fortunately this form of food poisoning is comparatively rare.

An article in the *Journal of the American Medical Association* for February 13, 1926, gives a summary of 56 outbreaks of botulism in the United States concerning which information is now available. Twenty-one of these occurred in 1922, 12 in 1923, 8 in 1924, 8 in 1925, and the remainder in previous years. A total of 150 cases with 124 deaths, or a case mortality of 78 per cent, has been recorded.

The foods responsible for outbreaks so far as known were:

Home canned string beans	19
Home canned corn	6
Home canned asparagus	2
Home canned spinach	2
Home canned chile sauce	1
Home canned pimento	1
Home canned beef	1
Home canned figs	1
Home canned chicken	1

Home canned mixed pickles	1
Home canned salmon	1
Commercially canned olives	3
Commercially canned spinach	2
Commercially canned sardines	2
Commercially canned clam juice	1
Commercially canned duck paste	1
Commercially canned peas	1
Commercially canned meat	1

Of these 56 outbreaks of botulism, obvious spoilage of the food was noticed in 41. In the remaining cases the food implicated was stated to be normal in odor and taste. Obviously greater care should be exercised to avoid eating any canned food that shows the slightest evidence of decomposition.

All of these forms of food poisoning may be avoided by refusing to eat any food of any character that is tainted or shows any signs of spoilage, and by proper cooking of food. Home-canned vegetables should be sterilized more carefully and should be boiled for about 15 minutes before using. Foods sold in cans are generally safe, if not obviously spoiled, for the manufacturers have learned of the danger of botulism, and now take unusual precaution to prevent it.

Intestinal parasites

Worms occupying the intestinal canal cause more or less disturbance of digestion and may cause convulsions in children, but produce no specific disease. Such worms belong to two classes, the nematodes, or worms having a round shape, and the cestodes, or flat worms, commonly called tape worms.

Nematodes. Round worms (*Ascaris lumbricoides*). These worms look much like the ordinary earthworm, and live in the small intestine. The female lays large numbers of eggs which pass out in the stools, and these eggs may be identified by microscopic examination. Infection is acquired by drinking contaminated water, eating raw vegetables that have become contaminated, and by flies.

Thread worms (*Oxyuris vermicularis*). This worm lives in the lower bowel, and methods of transmission are the same as

for the round worm. Children who habitually put their fingers in their mouths frequently reinfect themselves because these worms cause itching, especially at night, and the fingers become infected from scratching. Both of these varieties of worms may be expelled by appropriate medical treatment. The drugs used for expelling worms are known as anthelmintics.

THE RESPIRATORY DISEASES

At the present time the respiratory diseases cause more morbidity (sickness) and a higher mortality rate than any other group of diseases. These rates have been estimated in various ways. In a study made in one community it was found that 60 per cent of the total morbidity rate and 20 per cent of the total mortality rate was to be attributed to respiratory diseases. In a study of sickness among industrial workers (*United States Public Health Reports*, January 22, 1926) it was found that respiratory diseases accounted for 47 per cent of all cases of sickness reported during the last five years. Of 5000 public school children studied at Hagerstown, Maryland, the frequency of common colds was found to be more than twice as great as that of any other illness, and respiratory diseases constituted 46 per cent of all cases of sickness reported during three years.

In the following discussion, diseases that are spread by secretions from the mouth and nose have been classed as respiratory diseases. This includes smallpox, measles and scarlet fever, diseases that are not often included among the respiratory diseases in classifications based on the characteristics of disease rather than on modes of transmission.

As a group, the respiratory diseases are notoriously difficult to treat and to prevent, although there are notable exceptions. There is no satisfactory treatment for smallpox, but it can be prevented. There is a satisfactory treatment for diphtheria (antitoxin), though until very recently we have been unable to reduce the incidence of the disease perceptibly. But for influenza, whooping cough, mumps and common colds, neither a satisfactory method of treatment nor of prevention have been developed. However, the progress that has been made affords

the hope that we are only temporarily checked in the endeavor to control these diseases.

Smallpox

The organism that causes smallpox is unknown, but is probably a filterable virus. The disease is undoubtely spread by secretions from the mouth and nose, because unprotected persons may acquire the disease by contact with early cases, before the eruption has appeared. But the virus is also in the pustules and the crusts that form in the process of healing, and the inhalation of dust from such dried scabs will also transmit the disease.

From nine to fifteen days (the incubation period) after a susceptible person has been exposed to a case of smallpox, the disease commences with violent headache, backache, fever and general prostration. The characteristic eruption appears at about the third day of the disease as papules or red spots, which after a few days become hard and feel like shot in the skin. Later these become vesicles and the vesicles pustules about the ninth day of the disease. The disease lasts about two weeks. When present in epidemic form smallpox has a high mortality, but the greatest distress is caused by the repulsive appearance of the patient and the disfigurement that so frequently results.

Smallpox may be surely prevented by proper vaccination, which affords complete though not permanent immunity, for 99.9 per cent of those never vaccinated will "take" if the vaccine is potent. Of those revaccinated after one year, 14 to 28 per cent take. After five years, about 50 per cent take when revaccinated and after ten years about 55 per cent take when revaccinated.

Therefore, anyone directly exposed to smallpox should be vaccinated at once if a successful vaccination has not been made within nine months. For since vaccination develops faster than smallpox, this vaccination will confer protection. Whenever smallpox is present in the community, as it generally is in large cities, revaccination should be generally carried out at five-year intervals. If this were universally done, smallpox would probably become extinct.

At the present day, some who are unvaccinated escape smallpox

and believe that this is due to improved sanitation. There never was a greater error. They escape solely because, living in the midst of a vaccinated population, they are never exposed to the infection of smallpox. When a sufficient number of unvaccinated people accumulate in any community, an epidemic of smallpox almost invariably follows, which only differs from the epidemics that formerly devastated whole countries because everywhere the majority of the population have been vaccinated. The virus of smallpox appears to be almost ubiquitous, and is one of the most certain of infections. Practically 100 per cent of individuals not protected by vaccination will acquire the infection when once exposed to the disease.

It has never been possible to induce any population to submit to this simple procedure voluntarily, and for this reason we have smallpox always with us. Knowing that smallpox may be completely prevented by such vaccination and revaccination, some sanitary authorities have endeavored to make vaccination compulsory. Wherever vaccination has been thus enforced, smallpox disappears. Thus, in armies and navies where such a regulation can be properly enforced, smallpox ceases to appear among such troops even when they are compelled to mingle with populations where virulent smallpox is epidemic. But so far as civil populations are concerned compulsory vaccination has never been a complete success although there is much less smallpox in such a community than in precisely similar communities where vaccination is voluntary. Compulsory methods stir up opposition, and many evade the regulation since a considerable percentage of the people fear vaccination or do not believe in its efficacy. The best results will be obtained by the compulsory vaccination of all children admitted to the public schools and by education of the general public by repeated presentation of the facts, so that they will voluntarily seek revaccination. There is not space here to repeat the facts that prove the efficacy of vaccination, but its harmlessness may be reiterated. Vaccination, when properly performed, is a safe and harmless procedure, and the trivial inconvenience caused by vaccination cannot be compared for a moment with the disastrous results of the disease it prevents.

The antivaccinationists have often claimed that syphilis, tuberculosis and other diseases may be caused by vaccination. As vaccination is practised today with vaccine lymph taken from the cow, this is impossible. In a certain percentage of cases, very sore arms have resulted from local infection, but this infection is acquired after vaccination and not by means of the vaccination itself. This subsequent infection may be prevented by exerting care to keep the surrounding skin perfectly clean. Until the scab has separated, the vaccinated area should not be bathed, and children should be kept clean and prevented from playing in the dirt.

Scarlet fever

It has been shown recently that scarlet fever is caused by one of the varieties of haemolytic streptococci. This organism grows in the throat and produces a soluble toxin which is absorbed into the blood and causes the symptoms of scarlet fever, including the rash. The same symptoms have been produced by the injection of toxin produced in cultures of this organism.

The source of infection is the secretion from the nose and mouth of those suffering from the disease, and the infection must enter the body by the same routes. It is generally transmitted directly from one person to another and mild or undiagnosed cases are the main factor in the spread of disease. Scarlet fever is sometimes transmitted by milk, and more than 50 epidemics caused by infected milk have been reported. The desquamation of the skin does not convey the infection, and soiled clothes and bedding which were formerly considered important sources of infection, are probably negligible.

One attack of scarlet fever usually protects for life against subsequent attacks, and the recovery and subsequent immunity are both due to the production of an antitoxin capable of neutralizing the toxin produced by the infecting streptococcus.

Antistreptococcus serums have been on the market for over twenty years, but gradually became disused because of lack of potency. In 1924–1925, George F. and Gladys H. Dick, and Dochez, working independently have identified the type of

streptococcus causing scarlet fever, and have shown that this organism, produces a toxin. A true antitoxin has been produced by immunizing horses to gradually increasing doses of this toxin. The blood serum obtained from such horses is concentrated by methods that increase the potency of the antitoxin and reduce the amount of serum that must be given. If a sufficient dose of antitoxin is given early in the disease, there is marked improvement in the general symptoms within a few hours, and the rash disappears within 24 hours.

This antitoxic serum is not only curative but may also be used as a prophylactic to protect other children that have been exposed to scarlet fever. All children are not susceptible, because some have already developed sufficient antitoxin, and therefore do not require to be protected. It is possible to determine which children are susceptible by a simple test known as the Dick test because originally described by the two workers of that name. A minute amount of toxin is injected into the skin. If no antitoxin is present in the blood, and the child is susceptible, this toxin produces a red spot on the skin. If the child is not susceptible, no such spot is produced. The children that are thus known to be susceptible may be protected by a small injection of antitoxin, or better may be permanently immunized by minute doses of the toxin. In young children so treated, immunity is effected in about eight days, which makes it possible to suppress an epidemic.

Prior to 1924 the only method of controlling scarlet fever was isolation of cases, which was not very effective since many of these cases became carriers, as the result of chronic infection of the tonsil or sinuses and thereafter conveyed the disease to others either directly or by infecting milk supplies. With this new method of treatment and protection, both the incidence and mortality from scarlet fever should be greatly reduced.

Measles

The organism that causes measles has not yet been absolutely identified. Earlier work indicated that it was a filterable virus, but more recent investigators have incriminated the streptococci.

The diplococcus isolated by Tunnicliff in 1917 grows in cultures as a small streptococcus and is claimed to produce a toxin which causes a definite reaction when injected into the skin of persons who have not had measles, but not in those that have had the disease.

The virus is contained in the blood and in the secretions from the mouth and nose, and is transmitted by immediate contact with measles cases. Aerial transmission is also possible for short distances by means of infected droplets expelled in sneezing and coughing.

Measles begins with all the symptoms of a severe cold, and the eruption usually appears on the fourth day. As a result the child with measles commonly goes to school for a day or two, or otherwise mixes with other children for several days before the true nature of the illness is recognized, and such a child is highly infectious. Since this virus is one of the most certain infections of all known diseases, it follows that practically every child exposed to such an early case of measles, and not immune by reason of already having had measles, will develop measles after the usual incubation period of about fourteen days. Children usually acquire measles when they go to school, if they have not had it before. Cases are known in which an individual has had measles several times. Nevertheless in the vast majority of instances, an attack of the disease affords complete protection for life. Some confusion is caused because of another and much milder disease that is commonly called "German measles." German measles does not protect against true measles or vice versa.

In the past measles has been the most difficult of all acute infectious diseases to control. Measles cases were isolated as soon as recognized, but this had almost no effect in limiting the infection. To make isolation effective would require the isolation of all children who have not yet had measles at the first sign of a cold. This is not practicable.

The situation is now more hopeful. It has been found not only that serum from recent convalescent cases of measles is both prophylactic and curative, but that the blood serum of

adults who have had measles in childhood may be used to modify the disease in children so that it will assume only a mild form, and yet will give immunity for life. Still more important is the fact that Tunnicliff using the diplococcus that she isolated from measles cases, has produced an immune goat serum which acts as a prophylactic. If this serum is given to cases exposed to measles, not later than the fifth day after such exposure, complete protection is secured in about 90 per cent of the cases, and the small percentage who are not completely protected, develop only a very mild type of measles. This work needs confirmation, but at least suggests the possibility that eventually a serum may be prepared that will be both prophylactic and curative, and that with its aid measles can be completely controlled.

Whooping cough

Whooping cough is caused by a small bacillus named the Bordet-Gengou bacillus, after its discoverers. It grows in the lining of the bronchial tubes and is spread from child to child through the secretions of the nose and throat.

The disease commonly begins like an ordinary cold with a hard cough, but after about two weeks the cough becomes harder, more paroxysmal, and the characteristic "whoop" appears while drawing in the breath after such a paroxysm of coughing. This stage lasts about four weeks and gradually passes away. About two weeks elapse before it can be recognized as whooping cough; and during this period the child commonly continues to go to school and otherwise mingle with other children. A child is quite as infectious during this period as later when the "whoop" appears, and thus the disease is handed from one child to another.

Whooping cough is far more serious than is generally realized, because of the complications it causes. Although very distressing and causing malnutrition because of the vomiting associated with the cough, the disease itself is rarely fatal. But a considerable percentage of children having whooping cough develop broncho-pneumonia which is often fatal. Moreover in the weakened state following the disease children are more susceptible to other infections, such as tuberculosis. Indirectly, therefore, whooping cough is responsible for many deaths.

One attack of the disease commonly confers immunity for life, but at present this is about all the protection that is afforded. If children could be forbidden to mingle with other children as soon as the symptoms of any cold appeared, this would go far toward reducing the prevalence of whooping cough as well as measles and ordinary colds. No medicinal treatment has been found that will alleviate or shorten the duration of whooping cough. A vaccine prepared from the Bordet-Gengou bacillus has been used, but has been found of little value. It seems probable that the chlorine treatment to be described later is more effective than other methods of treatment.

Mumps

The organism causing this disease is unknown, but probably belongs to the group of filterable viruses. It is a disease of childhood and adolescence chiefly because one attack usually confers immunity to the disease for life. Any one who has not already had the disease, may acquire it.

The virus is present in the saliva of those infected, and cases of mumps may remain infectious for six weeks. The disease is transmitted chiefly by direct contact and by recent indirect contact, that is when a child places some toy in the mouth that has been recently in the mouth of the infected child. While the disease is not a serious one, and practically causes no mortality at all, it causes invalidism and loss of schooling because of its long duration. The incubation period is from two to three weeks so that when there are several children in a family, mumps may be present for months. There is no known method of treatment that can shorten the illness, and no known method of prevention other than isolation of the case for six weeks.

Diphtheria

The organism causing diphtheria is the bacillus of diphtheria. This organism grows in the throat or nose where it results in the formation of a greyish membrane. This causes a very sore throat, and in the days before antitoxin was available, this membrane frequently spread down the larynx (Adam's apple) and trachea

(windpipe) thus causing suffocation. The disease was formerly called membranous croup. The diphtheria bacillus produces a soluble toxin which enters the blood and causes the general symptoms of the disease; fever, marked depression, weakness of the heart, and later, various forms of paralysis.

The infection is usually received from some person who carries the bacilli in the throat or nose and who may be either a case of diphtheria or a carrier. The disease may also be transmitted by milk infected through handling by some person suffering from a mild case or who is a carrier. Since most of the cases of diphtheria are isolated, the spread of diphtheria is due almost entirely to mild missed cases of the disease and to carriers. The worst carriers are the convalescents who are released while still harboring diphtheria organisms in the throat. At the end of one month 85 per cent of cases of diphtheria are free from the diphtheria organism: after two months, 98 per cent are free. The remainder become dangerous carriers. In addition to these convalescent carriers, from 10 to 20 per cent of the members of the family become carriers through contact with the actual case. Cases of diphtheria and contacts should be held in quarantine until three negative cultures have been secured from both nose and throat.

It is very difficult to eradicate diphtheria bacilli from the throats of those who become carriers. Local treatment of the throat is generally useless and fails to get rid of the organisms because they are deeply embedded in the tonsils. Removal of the tonsils is usually successful, but this measure cannot be made compulsory. Owing to this difficulty in controlling carriers, until recently there have been just about as many cases of diphtheria each year although the mortality rate for this disease has been greatly reduced since the introduction of diphtheria antitoxin.

Diphtheria is chiefly a disease of children. Abbott analyzed 6640 cases of diphtheria according to age as shown by table 3. The majority of the adult population are not susceptible to diphtheria because they have developed a certain amount of antitoxin in the blood as the result of repeated infections with diphtheria bacilli in too small amounts to produce diphtheria or

with strains of organisms that do not produce the disease, but can confer a certain degree of immunity. We are able to tell which persons have this antitoxin by a test known as the Schick test. If a minute amount of diphtheria toxin is injected into the skin it will cause a bright red spot in the course of twenty-four hours if the individual has no antitoxin in the blood, but if this antitoxin is present the injection causes no results whatever because the antitoxin present neutralizes the injected toxin. By performing this test on large numbers of people of all ages it has been found that the period of greatest susceptibility to diphtheria is from the end of the first year to the end of the fifth year, during which time about half the children are susceptible to

TABLE 3

Relation between age and incidence of diphtheria

AGE	INCIDENCE OF DIPTHERIA	AGE	INCIDENCE OF DIPTHERIA
years	*per cent*	*years*	*per cent*
0–1	3.2	25–30	2.0
1–5	38.9	30–35	1.3
5–10	37.1	35–40	0.7
10–15	10.1	40–50	0.5
15–20	3.4	50–60	0.2
20–25	2.6	60 and over	0.1

diphtheria. After this age the percentage of susceptibles slowly decreases until among adults 90 per cent are immune.

Therefore of late years, an effort has been made to control diphtheria by immunizing all susceptible children. At first children were protected by giving a prophylactic injection of antitoxin to all who had been exposed to diphtheria. But the immunity so conferred was of short duration.

It was later found more satisfactory to immunize these children directly and so protect them permanently from the disease. Children are injected with a minute dose of diphtheria toxin almost neutralized by antitoxin. This causes no ill results, but does produce a little immunity. The amount of toxin-antitoxin mixture is gradually increased until three doses have been given, and the child is protected against diphtheria. Even if such a

child becomes infected, it does not become sick because the toxin produced by the infecting organism is neutralized as fast as it is absorbed into the blood, and immunity to diphtheria is increased still further. This method has now been tried out on a large scale. In New York State the death rate from diphtheria dropped from 20 per 100,000 in 1919, to 9.9 per 100,000 in 1924. This is due to the fact that since 1920 more than a million school children, and many thousands of children of pre-school age have been given the Shick test, and more than one-third of these, or a great majority of the susceptible children have been immunized against diphtheria by the injection of this toxin-antitoxin mixture. It seems probable that universal immunization of all children over six months of age would completely eradicate diphtheria in the course of a few years.

Tuberculosis

Tuberculosis is caused by the *Bacillus tuberculosis*. All evidence indicates that the respiratory tract is the route of infection in the majority of cases, the organism being transmitted by dried and pulverized sputum or by droplet infection. Cases of active tuberculosis of the lungs discharge enormous numbers of the bacilli in their sputum, and the organisms are capable of withstanding drying for long periods so that they may be found almost everywhere. They have often been found in the dust of houses and city streets, and this explains the fact that so large a percentage of adults that come to postmortem show evidences of infection with tuberculosis. Tuberculosis may also be transmitted by milk, and about 5 to 7 per cent of tuberculosis in man is of such bovine origin. But the majority of such infections consist of abdominal or glandular tuberculosis (scrofula) in children, scarcely any being pulmonary.

Tuberculosis affects all tissues and organs of the body and infection with it is so common that at least 75 per cent of all individuals over forty years of age show evidences of it. About 20 per cent of children of five years of age are infected, and the proportion of those infected increases steadily with age.

The methods of preventing infection with tuberculosis may be summarized as follows:

1. Diagnosis of existing cases. This has been facilitated in recent years by the great increase in clinics and other institutions where people can be examined free or at little charge, and by the provisions made by all board of health laboratories for the examination of sputum. A microscope, glass slides, sputum bottles, and a few simple stains are all that is necessary to stain suspected sputum in order to detect the presence of the bacillus of tuberculosis.

2. When tubercle bacilli have been detected in the sputum, all such cases are instructed to dispose of sputum in such a manner that it cannot serve to infect others. This may be done by burning it or collecting it in sputum cups containing 5 per cent carbolic or 2 per cent tricresol solution. A very large number of such active cases are at present cared for in sanatoria, where they are afforded the best chance for recovery and cease to become a source of infection. The multiplication of such sanatoria is one of the important causes for the reduction in the mortality of this disease. Large numbers of cases, diagnosed early and so treated, make complete recoveries.

3. The prevention of promiscuous spitting. This is now prohibited by city ordinances and people have been educated not to spit in public places to a surprising extent. A reading of Dickens' "American Notes" will show how universal this disgusting habit was in 1842.[1]

[1] "The Senate is a dignified and decorous body, and its proceedings are conducted with much gravity and order. Both Houses are handsomely carpeted; but the state to which the carpets are reduced by the universal disregard of the spittoon with which every honorable member is accommodated, and the extraordinary improvements on the pattern which are squirted and dabbled upon it in every direction do not admit of being described."

"It was a fine evening when we were passengers in the train; and watching the bright sunset from a little window, my attention was attracted to a remarkable appearance issuing from the windows of the gentlemen's car immediately in front of us, which I supposed for some time was occasioned by a number of industrious persons inside ripping open feather beds, and giving the feathers to the wind. At length it occurred to me that they were only spitting, which was indeed the case."

4. Reduction of tubercular infection from milk by meat inspection and follow up of herds found to be tubercular; by tuberculin testing of dairy herds and slaughter of infected animals and by pasteurization of milk. Infection by meat is practically unknown because the muscles are rarely affected with tuberculosis and even in such rare cases, cooking would kill the germ. Nevertheless, meat inspection is carried out by the United States Department of Agriculture. That this is thorough is shown by the fact that for the year ending June 30, 1924, of 79,966,913 animals given antemortem inspection, 4228 were condemned, and of 79,814,060 given postmortem inspection, 342,539 were condemned and over one million parts were condemned for 35 different causes, of which tuberculosis caused about half of the condemnations. Elimination of tuberculosis from dairy herds is one of the most important results of this inspection.

It may be asked very properly, if 75 per cent of the population become infected with all these measures enforced, what is the use of attempting to prevent infection. We take these measures to prevent overwhelming infection. We may be able to combat a mild infection and in conquering it may even build up some immunity or resistance to the disease, whereas a heavy or constantly repeated infection breaks down resistance and leads to active tuberculosis. Therefore, as the result of such measures, although the number of those infected may not have been materially decreased, the number of those suffering from *active* pulmonary tuberculosis has been decreased materially, and the mortality from tuberculosis has decreased rapidly during the past fifty years. A further explanation for this improvement lies in the character of the disease. Tuberculosis is a chronic disease that does not necessarily cause death and which frequently lasts many years. It is characterized by periods of dormancy, when the defensive forces of the body have gained the upper hand, alternating with periods of slow or rapid advance when conditions in the body are favorable to growth. Often some other disease, starvation, or periods of excessive fatigue, so weaken the defenses of the body that the disease again gains the upper hand. This explains the frequency of tuberculosis in prisons. The latent

infections become active as the result of confinement, and mental and physical depression.

Therefore the other important factor in the reduction of mortality is the building up of bodily resistance. So far as the general public is concerned there are many factors tending to increase bodily resistance that have become operative in recent years. We suffer from fewer other infections than we did fifty years ago, and to that extent our resistance to tuberculosis is increased. Hours of labor have decreased from twelve or fifteen to eight, habitations have been greatly improved, and there is more general prosperity and a better general state of nutrition. All such factors increase bodily resistance and are important causes contributing to an increased resistance to tuberculosis. The obvious way for the individual to avoid tuberculosis is to live a healthful life so far as conditions permit, avoiding defective ventilation, underfeeding, exposure, fatigue, and other predisposing causes. Plenty of fresh air and sunlight are imperative. Sunlight not only kills the bacilli of tuberculosis, but also builds up bodily resistance to infection. The main features in the treatment of all forms of tuberculosis are rest, good food, fresh air, and sunlight. Sunbaths are now used as a regular part of treatment with excellent results, particularly in cases of bone tuberculosis.

Pneumonia

There are two types of pneumonia, lobular or broncho-pneumonia, in which scattered areas of the lung become consolidated with inflammatory exudate, and lobar pneumonia in which an entire lobe of the lung becomes so filled up and consolidated. Broncho-pneumonia is much less serious and usually does not cause death except in children, the aged and those previously weakened by disease or other unfavorable influences. Broncho-pneumonia may be caused by a variety of organisms, that is, has no specific cause.

Lobar pneumonia, which is generally meant when simply speaking of pneumonia, is caused by an organism called the

pneumococcus. The pneumococcus leaves the infected person through the discharges of the mouth and nose, and enters new cases by the same route. The pneumococcus is a very delicate organism that easily dies, and has no independent existence in nature. Consequently infection must occur almost directly from person to person. But as cases of pneumonia are very ill and are necessarily confined to bed and so have contact with very few individuals, the disease is seldom spread directly from such cases, but by carriers. Lobar pneumonia is a very serious disease, beginning with a severe chill and followed by a high fever, cough with bloody sputum, difficulty in breathing and a general state of intoxication (absorption of toxin). An attack of pneumonia does not give any immunity against subsequent attacks. In some instances it appears to render the individual more susceptible to reinfection. Although cases of pneumonia are infrequent as compared with a disease like tuberculosis, yet it is common enough, and as it has a very high mortality rate, the death rate from pneumonia is often higher than that for tuberculosis.

Both Sternberg and Pasteur found the pneumococcus in the saliva of healthy individuals as early as 1890, before it was known that these organisms were the cause of lobar pneumonia. It has since been found that there are four types of the pneumococcus which all look alike under the microscope but which may be distinguished by serological tests. That is, if a rabbit is immunized to a certain pneumococcus, its blood serum will agglutinate all other pneumococci belonging to that type, but will not agglutinate (clump) pneumococci belonging to other types. Type IV includes the pneumococci commonly found in from 20 to 50 per cent of normal mouths. They are organisms of low virulence and do not cause pneumonia except under unusual circumstances, such as exposure to severe cold or other factors that lower resistance. In such cases a person develops pneumonia from the organism he has been carrying about with him perhaps for many years. But only about one-third of all pneumonias are caused in this way.

Types I and II are epidemic strains of considerable virulence,

and are responsible for nearly two-thirds of all cases of pneumonia. These organisms are not found in the mouth except in cases of pneumonia or those persons who have been in intimate contact with such a case. About 40 per cent of convalescents from pneumonia have these virulent pneumococci in the saliva and carry them usually for about a month, but sometimes for longer periods. About 10 per cent of those in contact with such cases acquire the virulent pneumococci and also carry them for about a month. Such carriers, moving freely in the community, are responsible for the transference of pneumonia. There is no method of prevention of pneumonia except to avoid contact with cases of pneumonia. Such cases should be regarded as infectious and visiting should be forbidden. Those caring for a case of pneumonia should use a mouth wash of Dobell's solution frequently. Since the pneumococci are in the saliva, this should help to prevent the acquisition of infection. The case of pneumonia should be treated similarly after the acute illness is over, and during convalescence. Avoidance of known infection and an endeavor to maintain the best state of health are the only measures of prevention that can be recommended at present.

Influenza

There are two types of influenza, the endemic, sometimes called grippe, which is constantly present, and while causing serious inconvenience seldom is fatal except to infants, the aged, and debilitated. The other type, having very similar symptoms, is epidemic and sweeps over the world at intervals of about twenty years, leaving a trail of deaths behind it. It is one of the major plagues easily comparable with bubonic plague in its disastrous results. It has been estimated that the influenza epidemic of 1918 resulted in 20,000,000 deaths in the whole population of the world. The case mortality from bubonic plague is higher, but plague does not spread over the whole world in the course of a year. It has been stated that in Bombay in the worst plague epidemic experienced in recent years, the highest mortality in one day was 433, while at the peak of the influenza epidemic a day's mortality was 768. In England and Wales, the highest

mortality rate for any other epidemic since registration of deaths began was 3033 per million in the cholera epidemic of 1849. But the mortality rate from influenza in 1918–1919, during a period of 46 weeks was 4774 per million of population.[2]

The first trustworthy records of this type of influenza date from the twelfth century and between 1173 and 1874 it appeared 86 different times. The first recorded appearance of epidemic influenza in the United States was in Massachusetts in 1627, and since that time it has appeared in the United States 22 times. There was a great epidemic in 1889–1890, and another in 1918–1919.

The cause of influenza is not known with certainty but is probably a filterable virus. It undoubtedly leaves the body in the discharges from the respiratory tract and probably is conveyed from person to person directly, and through the air infected by droplets and spray as is measles. The virus probably has no independent life outside the body. It spreads rapidly from person to person and about the country at the rate people travel. The epidemic of 1918 reached this country first near Boston, was in Philadelphia and Washington within several days, and reached San Francisco in about a week. Some immunity is undoubtedly afforded by an attack of the epidemic influenza, but individuals commonly suffer repeated attacks of lesser severity every year or two as the disease takes on its endemic characteristics.

No method of preventing this disease has proved of any avail. The attention of medical investigators all over the world has been turned to this problem and it can only be hoped that some method of limiting its spread may be found before the next great epidemic appears.

Cerebrospinal meningitis

Cerebrospinal meningitis is a disease caused by an inflammation of the meninges (membranes) of the brain and spinal cord. It occurs sporadically and in epidemic form, though even when epidemic the cases tend to be scattered and relatively few people

[2] From an article by E. O. Jordan, Professor of Bacteriology, University of Chicago.

are affected. Children and young adults are most apt to become infected and epidemics are prone to occur in schools, barracks and army camps.

The disease is caused by an organism called the meningococcus, which is so delicate and difficult to cultivate that it probably cannot live outside the body. The chief source of infection therefore must be by carriers. The organism is present in the back of the nose and throat (naso-pharynx) from which location it often gains entrance to the circulation and so is carried to the meninges of the brain where it causes a severe inflammation with a purulent exudate. In many cases the organism reaches the circulation in this way but does not become localized in the meninges and causes only a general illness so that the disease is often called cerebrospinal fever. When the membranes of the brain are affected there is violent headache, vomiting, fever and great prostration, followed by paralysis of certain nerves that arise in the brain, and later by unconsciousness and death. The diagnosis is made by lumbar puncture. That is, an aspirating needle is inserted between the vertebrae of the lumbar region of the back, so as to penetrate the membranes of the spinal cord, when the cerebrospinal fluid that bathes the spinal cord will run out through the needle. In fully developed cases of meningitis this fluid contains pus, and in any case the infecting organism is present and may be identified by staining the fluid and examining it under the microscope or by culture.

A serum has been developed that is very effective in this disease. It is prepared by immunizing horses to various strains of meningococcus. This serum is injected into the space around the spinal cord as soon as the disease has been diagnosed. Thus, if cerebrospinal fluid containing pus flowed from the needle after the cord was tapped, it is common practice to remove a considerable amount of this purulent fluid and to replace it at once with antimeningitic serum. The mortality of this disease, which was formerly about 80 per cent, has been reduced to about 30 per cent by this treatment.

Only a small percentage of those whose throats become infected with the meningococcus ever develop the disease, and the

rest become healthy carriers and are the essential factor in carrying on the disease because organisms in the blood or meninges cannot infect others. About 3 per cent of the general population are such carriers of the meningococcus. When conditions are favorable, usually in the fall or winter when other respiratory diseases are prone to increase, the number of carriers of meningococci also increase, and some of these carriers develop the disease. Convalescents may harbor these organisms in the naso-pharynx for three months or even longer.

The identification and isolation of such carriers is so difficult as to be practically impossible and is seldom attempted except in military camps where the personnel is subject to military discipline. The procedure is not very successful even under such circumstances. The best method of preventing the disease is to separate people more widely so that transference from person to person is less likely. This may be done by assigning each individual an amount of floor space that is in accordance with hygienic requirements.

Encephalitis lethargica

Encephalitis lethargica is commonly known as sleeping sickness, but this disease is not the same as African sleeping sickness. The condition commences with fever, pain in the head, and vomiting. The patient then becomes excessively sleepy and gradually arrives at a state in which he sleeps all the time. He can be aroused for a few moments, but at once falls asleep again. There is generally paralysis of certain of the eye muscles. This condition lasts several weeks, leading to death or gradual improvement and recovery. The mortality varies, but perhaps averages 25 per cent. In some cases that recover the mind is permanently deteriorated.

This peculiar disease is caused by infection of the brain with a form of filterable virus. This virus is present in the nose and throat and thence probably reaches the blood and is carried to the brain. Although there is no evidence that the virus of this disease is the same as that of influenza, encephalitis commonly follows epidemics of influenza. Thus encephalitis lethargica

was practically unknown in the United States prior to 1918, when the first case appeared following the great influenza epidemic of that year, and since that time about 1000 cases have occurred in certain cities with a total population of 22,500,000.

The virus has been cultivated and the disease produced in rabbits, but up to the present time no satisfactory method of treatment of the disease has been developed, and the isolation of cases is the only practical method of prevention.

Poliomyelitis

Infantile paralysis (poliomyelitis) is an infectious disease chiefly affecting children under sixteen years of age though from 3 to 10 per cent of the cases may occur in adults. The disease begins suddenly, often with diarrhoea and vomiting which is at first ascribed to improper food. This is followed by fever, headache, and restlessness, and after from one to four days, paralysis appears in certain groups of muscles, usually in the arms and legs, and this paralysis is commonly permanent. It is caused by inflammation and destruction of the nerve cells in the spinal cord from which the nerves to these muscles originate. In some cases the degree of paralysis is slight and recovery rapidly follows, but in other cases the paralysis is progressive and ends in death from paralysis of the respiratory muscles. The disease occurs in epidemic form, although even in the most severe epidemics relatively few cases develop. Thus in a severe epidemic in New York City in 1916, there were about 9000 cases or 3.8 cases per 1000 of total population.

Poliomyelitis is caused by a filter-passing virus. When the virus is once acquired by a susceptible individual, it passes by lymphatic channels from the nose to the brain where it multiplies. This virus has been cultivated and the disease produced in monkeys. It has been found in the nasal washings of both human and monkey cases, and is probably transferred from the nose of the infected person to the nose of other individuals. The organisms causing the disease are therefore carried about by healthy carriers, just as are so many other respiratory diseases. During an epidemic this virus is widely distributed, and the only

reason for the small number of cases lies in the fact that only relatively few are susceptible to this infection.

An outbreak of poliomyelitis in Cortland, New York, in 1926 was traced to infected milk. On December 7, a boy who worked on a dairy farm became sick with fever, headache, pain in the back and diarrhoea. He continued at work milking but noticed his hands were growing progressively weaker. On December 11, he was definitely paralyzed on his left side but continued milking with his right hand before his condition was noticed. Seven days later another case developed in Cortland and there were five more cases during the next three weeks. Every case occurred in families using milk from the dairy where the first case developed, and in a population of about 15,000, these were the only cases. While this is an isolated observation, it indicates that poliomyelitis like scarlet fever and diphtheria may at times be transmitted by milk, even though this is not the usual method of transfer.

At the present time the only means of prevention is the prompt isolation of the patient, and all those who have been in intimate contact with the patient for about two weeks. During an epidemic it would be advisable to keep children out of school and away from other children so far as possible. This is the more easily done as poliomyelitis differs from most respiratory infections in that epidemics commonly occur in the summer time. Promiscuous travelling is very undesirable during an epidemic, but when an epidemic is present in a city, it is good prophylaxis to take children away to the country for the summer.

The common cold

It is unnecessary to describe this condition. Every one has had a cold and some who are specially susceptible have a cold four or five times every year. It is thus the most frequent of all diseases and is the cause of much suffering and disability. Although never fatal itself, it undoubtedly lowers resistance and thus increases susceptibility to other more serious diseases.

The organism causing the common cold is not known with certainty, but all the evidence indicates that it is one of the group of so-called filterable viruses. That is, it will pass through a

filter that will hold back the smallest known bacteria. The infection is undoubtedly conveyed from person to person like other respiratory diseases. When one member of a family develops a cold, it often runs through the whole family. Colds have two periods of maximum incidence; the first, following cool weather of early fall, and the second in January or February during the coldest winter weather.

Medicinal treatment for a cold is of very little value, and we seem to be helpless to prevent colds unless the treatment by chlorine recommended by Vedder and Sawyer in 1924 should prove to be practical. These investigators developed a method whereby chlorine gas could be introduced into the air of a room in proper proportion. The amount of chlorine so introduced must be very carefully regulated because an excess of chlorine is very irritating, and of course the pure gas is a violent poison. However, when it is so regulated these investigators found the chlorine air mixture to be very efficacious in the treatment of colds and whooping cough. A very high percentage of cases of common colds were cured or greatly relieved by several one-hour treatments in such an inhalatorium or "gassing chamber," and from 15 to 20 per cent of cases of whooping cough were considerably benefitted so that the paroxysms became less frequent and milder, and vomiting ceased.

Unfortunately the installation of such a "gassing chamber" is quite expensive, and rather difficult to control. As a consequence, although a number of physicians have confirmed these claims, a number of others have failed to obtain satisfactory results and have become discouraged, and this method of treatment has not yet received the general endorsement of the medical profession. But since treatment with chlorine not only cures certain cases, but gives evidence of being of great value in the prevention of a number of respiratory diseases that have heretofore been quite uncontrollable, it seems probable that this method of treating certain respiratory diseases will gradually come to general acceptance, and that the prevalence of such respiratory diseases will be correspondingly reduced.

DISEASES TRANSMITTED BY INSECTS

In nearly every case in which a disease is transmitted by insects, a particular species of insect is the only one capable of transmitting the disease in question. Not only so, but when the disease organism is a protozoon, it usually undergoes one cycle of development in the insect host and another cycle of development in the human host. A study of the insect transmission of disease is therefore extraordinarily complicated, and although very interesting, only a few of the more important diseases can be discussed in a work of this character.

Mosquitoes

The important diseases transmitted by mosquitoes are malaria, yellow fever, dengue, and filariasis.

Malaria. It is unnecessary to describe "chills and fever" to anyone who has lived where malaria is at all common, which includes most of the Southern States, as well as many other localities. It is one of the commonest of all diseases, and causes in the aggregate an inestimable amount of suffering and economic loss. There are three varieties of the malaria plasmodium, the protozoon that causes malaria. One produces tertian fever, the commonest form of the disease; one produces quartan fever which is relatively rare; and one produces aestivo-autumnal malaria, variously known as remittent fever, tropical malaria, and pernicious malaria.

Malaria is transmitted only by the bite of that genus (family) of mosquitoes known as Anopheles. There are more than fifty species of Anopheles mosquitoes, of which at least 16 have been known to transmit malaria. Only the female mosquito bites, and the meal of blood is supposed to be necessary for the development of her eggs. In this case it may be truly said that the "female of the species is deadlier than the male." The male mosquito may be identified by its feathery antennae.

Anopheles mosquitoes differ from all others in certain anatomical peculiarities that are used by zoölogists in the classification of mosquitoes. But the identification of mosquitoes this

way requires a microscope and a considerable knowledge of mosquito anatomy which is not commonly taught in our schools. Nevertheless, we can all identify the Anopheles mosquito by the peculiar position it assumes. All other mosquitoes when resting on a wall or alighting on the skin hold their bodies parallel to the surface they are resting on. The Anopheles on the contrary stand with the body held straight away from the surface at an angle of about 45 degrees, with its proboscis in the position of "present arms," thus appearing always ready to dig in. "Semper paratus" is the motto of this family. Many, though not all, of these Anopheles have spotted wings as is indicated by their names. Thus *Anopheles quadrimaculatus* (four-spotted) is the principal carrier of malaria in the Southern States. Darling found that from 2 to 5 per cent of mosquitoes of this species from different localities in the South were infected with malaria.

The malarial parasite undergoes one cycle of development in man and another in the mosquito.

The human cycle. After being injected by the infected mosquito, the malaria parasite invades the red blood corpuscles of man. At first it is very small, but it becomes gradually larger until it fills the entire corpuscle. It then breaks up into from 15 to 20 spores which are set free in the blood and each spore invades a fresh corpuscle and repeats the cycle of development. The tertian parasite requires seventy-two hours to complete this development and the chill and fever is coincident with this sporulation which occurs in the majority of the parasites at the same time. The quartan parasite requires eighty-four hours to complete its cycle of development so that the malarial paroxysm occurs only every four days. The aestivo-autumnal parasite undergoes a somewhat different form of development, so that the fever in these cases is continuous although there are daily exacerbations and remissions. In all three varieties of malaria, after the disease has lasted for a certain variable period, the parasite develops certain sexual forms of both male and female type. These sexual forms remain in the blood for many months and undergo no further development unless the patient is bitten by an Anopheles mosquito.

The mosquito cycle. But should such a patient be bitten by an anopheline mosquito, the insect takes into its stomach a number of these sexual forms of the parasite. There the male parasite emits flagella which penetrate and fertilize the female parasites. These latter then become elongated and penetrate the wall of the stomach of the mosquito. Here they remain and develop into cysts, and each cyst generates a large number of spindle-shaped forms called sporozoites. When these sporozoites are mature, the cyst ruptures into the body cavity of the mosquito and the sporozoites then pass into the salivary gland of the mosquito which lies free in the body cavity. Such a mosquito is infective for the rest of its life. When the mosquito bites, it injects saliva from this gland into the wound for the purpose of causing irritation and so increasing the blood supply to the part, thus rendering it easier for the mosquito to get a meal of blood. It is this injection of saliva that causes the itching and swelling after mosquito bites. When the salivary gland contains these malarial sporozoites, these are also injected into the circulation of the patient affording the meal, and each sporozoite enters a red blood cell and begins to go through the cycle of development in the human host, and who, after the parasites have multiplied sufficiently, himself in turn suffers from chills and fever. The sexual cycle of development in the mosquito lasts from ten to twelve days. The asexual cycle in the human host lasts indefinitely until he is treated with quinine or until he becomes more or less habituated to the presence of the parasite. As this occurs, chills and fever happen more or less rarely until finally they only appear at such times as the patient suffers from cold or has his resistance lowered in other ways.

Malaria can be prevented in three ways:

1. By treating all cases efficiently so that they will not infect mosquitoes.
2. By killing all malarial mosquitoes (Anopheles).
3. By preventing mosquitoes from biting (screening).

Treatment. Quinine is a specific for malaria, that is, cures the disease by killing the parasites. But though 30 grains of quinine for several days will put a stop to the attacks of chills and fever

very promptly, such cases are not cured, because some parasites remain, and in the course of time the patient will suffer a relapse. In order to produce a cure and kill all parasites, a long course of quinine is required. The least treatment recommended is as follows: 30 grains of quinine daily until all symptoms are gone; then 15 grains of quinine daily for two weeks; then 10 grains of quinine daily for two weeks; then 6 grains of quinine daily for at least two months. Thus quinine would be taken continuously for at least three months.

If this treatment were followed in every case, not only would that case be permanently cured, but the sexual forms (gametocytes) would not be formed and no mosquitoes could become infected from such a case. It will be seen at once that if every fresh case of malaria were so treated, the malarial parasite would become extinct and the disease would disappear. The fact that we have so much malaria is due largely to inefficient treatment, which permits the sexual forms to develop. Since almost all mosquitoes die during cold weather, in temperate climates the infection is carried over until the next year by these sexual forms in the human host, and these infect a new crop of mosquitoes the following summer.

Mosquito control. Mosquitoes lay their eggs (about 100) on the surface of water, and the eggs develop into "wigglers" in two or three days. The wigglers have to come up to the surface to breathe, and when disturbed swim to the bottom by jerks. Such wigglers grow rapidly larger and after from eleven to twenty-one days go into a resting stage or pupa in which stage the transformation to the adult mosquito occurs. The pupae do not eat, but must also come to the surface to breathe. When the development is complete, the pupa comes to the surface of the water, the back of the thorax splits open, and the adult mosquito emerges, dries its wings and flies away. Oiling the water kills all mosquitoes in the larval stage (wigglers) because they are unable to project their breathing tube through the film of oil and therefore cannot breathe.

The best way to get rid of mosquitoes is to drain or fill all places where water accumulates. If this is impossible, breeding of

mosquitoes may be prevented by oiling or poisoning the water in such accumulations. Oil may be applied to pools or ponds, and to the edges of deep lakes, the only part of large bodies of water where mosquitoes breed. It may also be applied in the form of a continuous drip to ditches and small streams. In the prevention of malaria, a special search is made for the breeding places of Anopheles, and attention is concentrated on these places. Oiling must be repeated at least every two weeks to be effective.

Screening. The Anopheles mosquito bites only at night, and this was the origin of the belief that night air caused malaria. The word malaria itself means bad air. Although it was the mosquitoes and not the air itself that caused the disease, the observation that malaria was acquired at night was correct. In malarial regions houses should be screened and beds should be covered with mosquito nets, and people should keep within doors as much as is possible after nightfall.

Of these three methods, proper treatment of malarial cases and mosquito extermination are the most effective. Fortunately, it is not necessary to cure every case or to get rid of all mosquitoes in order to greatly reduce the prevalence of malaria. For whenever the number of cases or the number of anopheline mosquitoes becomes reduced to a certain point, the disease fails to spread. According to the laws of chance it becomes increasingly difficult for an Anopheles to find and bite a case of malaria, and still more improbable that these few infected mosquitoes will live to bite another victim. By these methods the prevalence of malaria has been remarkably reduced in many localities in the United States; and many tropical countries like Panama, the Malay States, and certain parts of the Philippines, where white men were unable to live because of malaria, have now been made comparatively safe.

Yellow fever is a disease that formerly occurred in epidemic form in the Southern States and occasionally reached as far north as Philadelphia. The disease was very serious, having a heavy mortality, and terrorized whole communities. It was against this disease that shot-gun quarantines were used. Since we have learned the method of transmission as the result of the work of

Walter Reed, the disease has never spread in the United States, and is gradually being obliterated all over the areas that were formerly constantly infected.

Yellow fever is caused by a filterable virus that has not yet been cultivated. This virus can only be carried from one case to another by the bite of a mosquito called the *Aedes egypti* by Americans, and *Aedes argenteus* by the rest of the world. (The zoölogists have changed the name of this mosquito three time within the past twenty years, and hunting up new names for it appears to be their favorite indoor sport. It was first the *Stegomyia fasciata*, then the *Stegomyia calopus*, and now the *Aedes egypti*. There are only a few million different forms of animal life, but the zoölogists probably think that in time we would learn them all and know as much as they do if they did not keep on changing their names.) This mosquito is black, with a white lyre-shaped marking on its back and white-banded legs, which gives it a grey appearance. It flies in a very erratic fashion so that it is difficult to catch, and bites in the daytime by preference, though it will also bite by artificial light. It almost always bites from the rear or in unsuspected spots, so that it is very efficient as a disease transmitter. The organism of yellow fever goes through a cycle of development in the mosquito which lasts from twelve to fourteen days, and thereafter the mosquito may transmit the disease for the rest of its life which averages about one hundred and fifty days.

But yellow fever is much easier to prevent than malaria for several reasons. First, the blood of the yellow fever patient is only infectious during the first three days of the fever, whereas cases of malaria may be infectious for weeks and months. The yellow fever mosquito (Aedes) must therefore bite during the first three days of the disease in order to become infected. Secondly, the patient who recovers from yellow fever is permanently immune to that infection and can never have it again, while malaria confers no immunity, and a patient cured of malaria can be reinfected again and again. The third reason that yellow fever is easier to control is that the Aedes is a house mosquito. It likes to hide in dark corners of the house and it breeds in small ac-

cumulations of water about the house, such as cisterns, rain barrels, water buckets, tin cans, roof gutters, etc. This fact made the mosquito more efficient as a transmitter of yellow fever, because infected mosquitoes would stay about a house and bite anyone who entered. Now that the fact is known, it is easier to eradicate this mosquito than the Anopheles, a species that lives over large areas outdoors. The infected Aedes in the house can be killed by fumigation, and breeding may be prevented by screening cisterns, water barrels and other necessary water containers, and cleaning up all other accumulations of water about the house.

In eradicating yellow fever the work is carried on from both angles. There must be a prompt notification of all suspicious cases that might be yellow fever. Such cases are at once placed under a mosquito bar or in a screened hospital ward so that no mosquito can bite them. The house is then fumigated in order to kill any infected mosquitoes already there. By following this rule very few infected mosquitoes ever escape to bite another victim. Secondly, a house to house inspection is made for mosquito breeding and all wigglers are killed and the proper steps are taken to prevent further breeding. By these simple measures yellow fever can be eradicated from any locality, even when as in Cuba, it had been present uninterruptedly for one hundred and fifty years.

The incubation period of yellow fever has been accurately observed from experimental cases and varies from three to six days. The period of development of the virus in the mosquito plus the incubation period is from fifteen to twenty days. At least fifteen days must elapse after the introduction of a case of yellow fever into a new locality before the appearance of a secondary case.

In quarantining against yellow fever a detention of six days is the general rule as this is about the longest possible incubation period. But yellow fever is now limited to a few areas, and quarantine against this disease has become more and more infrequent.

Dengue, often called "break bone fever," has a method of transmission almost identical with that of yellow fever. Dengue is a

disease that occurs in epidemic form over large areas of the southern United States, and in many tropical countries, and causes a great deal of suffering and disability. It commonly begins suddenly with a high fever, splitting headache, pain in the back, and in all the joints and muscles, and great prostration. This lasts for about three days when there is a remission followed by another rise of temperature and pain which is generally less severe than during the first three days. Skin eruptions usually occur. This illness lasts for seven to ten days and recovery is gradual, but no permanent immunity is conferred and residents in the tropics may suffer several attacks. In spite of the severe nature of the attack it causes no alarm because it differs from almost all other known diseases in that no one was ever known to die of it.

Dengue is caused by another filterable virus, at present unknown and not yet cultivated, but it has been shown experimentally by the United States Army Medical Department Research Board at Manila, and by others that the disease is transmitted by the bite of the *Aedes egypti*, the same mosquito that transmits yellow fever. Like yellow fever, the dengue patient is infective only during the first three days of the disease, and the organism undergoes a cycle or development in the mosquito lasting about eleven days, which must elapse before the infected mosquito can transmit the disease to man. It has been shown that the mosquito remains infective for sixty days, and it is probably infective during the remainder of its life.

The methods of prevention of this disease are the same as for yellow fever, but owing to the fact that it causes no mortality, less attention has been paid to its prevention. At the very least dengue cases should be screened during the first three days of the illness, and an effort should be made at mosquito eradication for the sake of comfort, if nothing else. But with so many really dangerous diseases to combat, it is difficult to excite any enthusiasm about controlling dengue, and patients that have it receive very little sympathy. In the Philippines it is regarded as one of the inevitable concomitants of tropical residence.

Filariasis. There are several species of filaria, all parasitic

worms, but the commonest filaria of man is known as *Filaria bancrofti.* It occurs rarely in certain localities in the southern part of the United States, but is quite common in many tropical countries. The adult worms are from 2 to 4 inches in length, and live in the lymphatic vessels of various parts of the body. The adult female gives birth to large numbers of embryos (microfilariae) which find their way into the blood, through which they swim freely, being small enough to pass through the capillaries. The most interesting feature of these embryos is the fact that they appear in the peripheral circulation in large numbers only during the night, and during the day remain chiefly in the blood of the interior of the body. Thus, if we wish to find these filariae in a drop of blood from the finger or ear, we must draw this blood at night. It was this peculiar nocturnal habit of the parasite which led Manson to conclude that it must be transmitted by some nocturnal biting insect and so led to the first demonstration of a mosquito-borne disease. There is undoubtedly a simple mechanical explanation for this nocturnal habit of the parasite, but it has not yet been elucidated, though many theories have been proposed.

Mosquitoes of three different genera (families) have been proven to transmit this parasite: *Culex fatigans*, *Anopheles Rossi*, and *Stegomyia pseudoscutellaris.* When the mosquito sucks blood containing these micro-filariae, the worms penetrate the stomach of the mosquito and migrate to the muscles of the thorax where they remain while undergoing development. After from twelve to fourteen days, this development is complete, and they again migrate to the proboscis. The next time the mosquito feeds these worms escape from the proboscis of the mosquito into the circulation of the new host, and find their way to the lymphatics where they become sexually mature and produce a new brood of micro-filariae to circulate in the blood and infect new mosquitoes.

Another curious thing about this parasite is that the presence of millions of these microfilariae in the blood, not only causes no disease, but does not appear to inconvenience the patient in the least. The parasite only causes disturbance mechanically when the adult worm blocks an important lymphatic channel, which

results in elephantiasis (enlargement like an elephant) of the part drained by this lymphatic. The legs and scrotum are more frequently so affected, and in regions where filariasis is common, patients who are unable to walk because of these enormous enlargements are frequently seen.

Flies

The common house fly and other flies may transmit the intestinal diseases, typhoid fever, dysentery, and cholera, and probably also tuberculosis and some other diseases mechanically, simply by carrying these organisms on their feet which they wipe on bread or other articles of food. But several species of flies act as true intermediate hosts for certain parasites. The most important of these diseases is African trypanosomiasis which is transmitted by tsetse flies. There are a large number of species of trypanosomes, protozoan (unicellular) parasites capable of living in the blood of their natural host without causing serious disease. Thus the rat has a trypanosome called *T. lewisi* which causes no disease in the rat, and is transmitted from rat to rat by the rat flea. The big game animals of Africa also have several varieties of these trypanosomes in their blood which inconvenience them very little. But one variety, *T. brucei*, when carried to domestic cattle by a species of tsetse fly, called *Glossina palpalis*, causes serious illness and certain death of such cattle.

African sleeping sickness. Another variety, *T. gambiense*, when carried to man by the bite of another species of tsetse fly (*Glossina morsitans*) causes African sleeping sickness which in the past has also been uniformly fatal and which has depopulated whole areas of Africa. *T. gambiense* occurs naturally in certain wild game animals of Africa. From 18 to 25 per cent of the waterbuck and bushbuck examined have been found to be infected with this parasite. The fly, *Glossina morsitans* is abundant near streams, and bites these animals when they come to water. When the fly becomes thus infected, it can carry these trypanosomes to man mechanically for a short and variable period, possibly as long as two days. But thereafter it cannot transmit

the disease for from fourteen to twenty-five days during which time the trypanosome undergoes a cycle of development in the fly. At the end of that time, the salivary glands are infected with the parasite, and the fly can then transmit the infection every time it bites for the rest of its life.

When a man is so infected, the trypanosomes multiply in the blood by simple longitudinal division, so that in a short time the blood is teeming with them. They also invade the brain and spinal cord, and may be found in the cerebrospinal fluid withdrawn by lumbar puncture.

The first symptoms of sleeping sickness occur several weeks after the patient has been bitten by an infected tsetse fly, and begin with fever, general weakness and enlarged lymph glands, followed by progressive emaciation and oedema (dropsy) of the extremities and face. Later when the brain becomes involved, nervous symptoms predominate such as tremors, paralysis, mental disturbance and especially somnolence which deepens to unconsciousness and death, usually from three to six months after infection.

This disease has been known for one hundred years on the west coast of Africa, but the cause was only discovered in 1903. In the old slaveship days, negroes from the Congo were sometimes affected by it. They were lethargic and took little interest, passing into a condition of somnolence in which they took no food and finally died. The slavers attributed this to home sickness and a desire to die, especially as there was no extension of the disease. We now know that this was because there were no tsetse flies on the ship. At present, sleeping sickness is confined to certain regions of Africa where both game and the tsetse fly abound. The incidence in northern Rhodesia is given as about three to four per thousand of the total population.

Unfortunately no means has yet been found of eradicating the tsetse fly which breeds in the ground in moist places along river banks, and the only sanitary measure of value has been to move away from the areas known to be infected. Within the last few years several synthetic drugs have been prepared which give prospect of effecting a cure in this hitherto incurable infection.

It is possible to infect laboratory animals, rats, guinea pigs and rabbits with these trypanosomes. A long series of drugs has been prepared and tested upon such infected laboratory animals. Many have been found that gave temporary relief, but failed to cause a permanent cure. But one of the latest and best, called tryparsamide, does produce definite cures in laboratory animals, and has been tested in cases of sleeping sickness in the Belgian Congo. All of these patients were greatly improved, and about 15 per cent have remained well for several years, whereas the untreated case seldom lives more than six months or at most a year. There is some ground for hope, therefore, that an effective treatment has been finally developed for this condition. This is a good illustration of the method of modern chemotherapy. We no longer have to wait centuries to discover a remedy by chance, but many investigators set out on a definite search, testing on animals all compounds that experience leads them to believe might have therapeutic value, and when one is found that has a certain value, new variants of this compound are prepared and tested, until one that is satisfactory is found. Such a compound must kill the parasite without being unduly poisonous to the patient. In addition to this indispensable characteristic, a satisfactory drug should fulfill numerous other conditions. It should be stable, soluble and easily administered without injury to local tissues. It should not be excreted or destroyed in the body until it has had time to act upon the infecting agent, and it should be impossible for the parasite to develop a tolerance for the drug. Few if any drugs that have been synthesized or found in nature conform to all these requirements, but great improvements have been made through attempts to meet these conditions.

Several other diseases are transmitted by other species of flies, but as these diseases rarely occur in the United States and are of no general interest, we may omit them here.

Fleas

Plague This disease is present in the United States today and is only prevented from being the major pestilence that it was

for centuries because we have learned its method of transmission and can prevent its epidemic spread.

Plague is caused by the *Bacillus pestis* and is primarily a rat disease. It is carried from rat to rat by the bite of the flea. In sucking blood from a rat having plague, plague bacilli enter the stomach of the flea, and multiply there. When the flea bites another rat the bacilli are either injected into the wound by the flea or deposited in the excreta near the wound where they are subsequently rubbed into the wound by scratching. Plague is one of the most virulent of all infections, and it has been shown experimentally that a single plague bacillus injected under the skin will produce the disease with certainty.

Rats therefore constitute the reservoir of infection, and it has been observed that rats die in large numbers before cases of human plague appear. When a rat dies, the fleas leave the body as soon as it is cold. They prefer to find another rat, but when such a rat dies in the house, if the fleas do not find another rat, and become hungry, they will bite man and so transfer plague to man. Practically all cases of bubonic plague are contracted in this manner from the bite of a flea that had become infected from a plague-infected rat.

Plague may be pneumonic, or a pneumonia caused by the plague bacillus. Fortunately this is not the usual form, for it is spread from case to case like other respiratory diseases, is very difficult to control and its mortality is nearly 100 per cent. Plague seldom appears first in this form, but as bubonic plague. Bubonic plague, in addition to high fever and great prostration is characterized by the buboes or swellings of the lymph glands. These commonly appear in the groin, sometimes in the armpit. The location of the bubo is usually determined by the portal of entry of the plague bacillus. When this enters the lower extremities the bubo is in the groin, and if it enters by the arm, the bubo is in the armpit. For the bacilli are carried up the lymph channels from the portal of entry to the nearest lymph gland. In addition to these typical buboes, haemorrhages occur frequently under the skin, which later turn black in color, and because of this plague has often been called "the black death." The mor-

tality from plague is probably higher than in any other disease, being as a rule from 80 to 90 per cent of all cases.

Plague appeared in Europe for the first time during the reign of the Roman emperor Justinian. Beginning in Egypt in 542 A.D., it passed to Constantinople, where 10,000 people are said to have died in a single day, and from this point plague spread over the whole of the Roman Empire. From that time on, plague was always smouldering in Europe, with great epidemics from time to time. One of the greatest occurred in the fourteenth century, when it is estimated that plague killed 25,000,000 people or a quarter of the whole population of Europe, and some districts were depopulated. In 1352, two-thirds of the academic population of Oxford died. Plague is described several times in literature. It was during the plague in Florence in 1348 that the scene of Boccacio's "Decameron" was laid, and in the author's "Introduction to the Ladies," the ravages of the plague in Florence at that time are pictured. The great plague in London is described in Defoe's "Journal of the Plague Year," where of an estimated population of 460,000, 68,600 died of plague in one year (1664–1665). In 1894 plague appeared in Hong Kong and again spread over most of the civilized world. It was in this year at Hong Kong that Yersin, a Frenchman, and Kitasato, a Japanese, independently discovered the bacillus of plague. It spread to India and was first recognized in Bombay in 1896, and more than 10,000,000 died of plague in this epidemic in India alone. It was as the result of the extensive experiments of the Indian Plague Commission published in 1907 that the method of transmission was definitely proved. In 1900 plague reached San Francisco, and the infection still lingers today in California in infected ground squirrels, although as the result of proper sanitary measures, human cases appear very rarely. Plague also appeared in New Orleans about 1920, but was promptly stamped out.

Obviously in attempting to control plague an effort is made to destroy infected rats. When plague occurs rats are extensively destroyed by trapping. Every rat caught is labelled with the locality where it was caught and is examined for plague. A spot map is made of all foci of infection, and all human cases and all

rat cases of plague found constitute such foci. Each focus is surrounded by a sufficient cordon to prevent infected rats from escaping, and working toward the center, a determined effort is made to kill all rats. Rats are destroyed by trapping, poisoning, and by destroying all rat harborages. In this process, floors and walls are torn open, and escaping rats are caught by terriers, cats or ferrets. If this work is not commenced until plague is epidemic, the work is of herculean dimensions, and very expensive. On the other hand when this is done as soon as the first case is recognized, the task is relatively simple. It is this prompt action that has prevented plague from spreading in the United States.

It is impossible to exterminate rats. It has been estimated that there are just as many rats as there are people, and if nine-tenths of the rats could be killed, the remaining tenth would breed so fast that in a short time there would be as many as ever. All that plague campaigns can do is to destroy all plague-infected rats. But it is possible to avoid having many rats on the premises, by eliminating rat harbors and food. Houses and barns should be constructed so as to afford no shelter for rats. This may be done by having no hollow spaces in walls or floors, and by building houses either on solid rat proof foundations, or upon posts provided with rat guards so that rats cannot climb to the house or live underneath. Second, no food should be left accessible to rats. They always congregate where there is much food, and food should be kept in rat-proof containers so far as possible, and never left scattered about. This is especially necessary in markets, grocers' stores, and granaries. Finally, rats are not so apt to invade places where cats are kept even though the cats do not catch many rats, and they may be kept down by trapping and poisoning. Rats cost millions of dollars annually, for they spoil more food than they eat, and often cause fires by chewing off the insulation of electric wires. It is sound economic policy, as well as good sanitation, for every householder to make a determined effort to keep down the rat population. Whenever a new house, barn, or warehouse is to be built, it will be well to consider the various methods of making it relatively rat-proof.

Plague is spread from country to country by rats on ships. Hence ships are fumigated at frequent intervals to kill all rats, and ships arriving from ports that are known to be plague-infected are in addition not permitted to dock; or if so permitted, they must keep a space of free water between the ship and the dock, no gang planks may be left down after dark, sentries are posted on them in the daytime, and all hawsers are furnished with rat guards or circular pieces of tin about a foot in diameter which prevent rats from walking ashore along these ropes. These measures prevent the frequent importation of plague rats into countries now free from plague. Plague was introduced into Manila first in 1899 and again in 1910, but was soon stamped out, and as the result of such precautions has not been reintroduced since, although ships are coming constantly from ports where plague is present.

Lice

Typhus fever. The disease is probably caused by a peculiar microörganism known as the *Rickettsia prowazeki*, and is spread by the bite of infected lice. This organism received its name from its two discovers, Ricketts and Prowazek who both lost their lives in the study of typhus fever. Nearly all the doctors who have attempted to identify the causal organism of typhus have died of the disease. The organism is present in large numbers in the body of infected lice, and if a single such louse is ground up and injected into a monkey or guinea pig, it will transmit the disease. But the louse, like Artemus Ward's kangaroo, is "an amusing little cuss." He can live only at body temperature and must be fed every day. Hence they cannot be raised in an incubator, and when an investigator wishes to experiment with lice he must raise them on his own person. This is done by wearing pill boxes containing the lice strapped to the skin with adhesive plaster. The bottom of the pill box is removed and a layer of gauze is substituted, so that the lice may bite, but cannot escape. Of course, the investigator endeavors to start with non-infected lice, but when typhus is common, experience indicates that sooner or later he becomes bitten by some louse that was not raised as a

pet. It would all be very humorous if it had not resulted in the sacrifice of many able scientists. But as the result of this self-sacrificing work, continued since 1909 when Nicolle first showed that typhus could be conveyed to a monkey from the bite of a louse that had previously bitten a typhus fever patient, we know sufficient concerning this disease to prevent its occurrence in epidemic form.

Infection occurs either as the result of the bite of infected lice, or from crushing lice upon the skin or rubbing excreta of lice into the skin during scratching. Lice that have once been infected retain this infectivity during the remainder of their life. The body louse (*Pediculus vestimenti*) is the usual transmitter, but head lice (*Pediculus capitis*) may also transmit typhus.

Typhus has always been closely associated with poverty and overcrowding. Epidemics of typhus have always been common among armies, on ships and in jails and for this reason has been called at various times, camp fever, ship fever and jail fever. Typhus is found all over the world in temperate climates. It is seldom found in the tropics where the heat is too great for the body louse to thrive. Russia has always been liable to serious epidemics, and between 1905 and 1911, it has been estimated that 665,000 cases and 54,000 deaths occurred there. Naturally, during the World War typhus was constantly present, among Russian, German and other troops. In 1915, a very serious epidemic occurred in Servia where it is believed that 500,000 cases occurred with 120,000 deaths. The mortality from typhus averages about 10 per cent, but is much higher among patients over forty years of age. One attack confers a permanent immunity, so that in time epidemics gradually wane even in the absence of sanitary measures, for lack of fresh material.

Doctors and nurses have always been peculiarly susceptible to this infection and the reason is now apparent since in handling lousy patients it is very easy inadvertently to acquire one or two infected lice, especially as lice do not like much heat and leave the body of patients having a fever. This fact is so well recognized that during the war certain Russians and Servians, with perverted logic, reasoned that to have plenty of lice indicated a

condition of robust health and objected strenuously to having their pets removed.

Typhus is a disease of the "great unwashed," though when it is present in epidemic form, cleanly people may contract it by picking up infected lice in railroad coaches and in crowds. During the war almost all soldiers became lousy and lice were known as "cooties" (cuties). One division was examined in the trenches in France, and 95 per cent of the men were found to be infested with an average of 20 lice per man. Five per cent were maximum cases, the number of lice ranging from 200 to 10,000 per man. The reason for this state of affairs was the fact that soldiers were unable to wash or to launder their clothes.

Epidemics of typhus occurred in the United States between 1867 and 1870. Between 1881 and 1882, over 700 cases of typhus occurred in New York City, and in 1883 a small epidemic occurred in the Philadelphia Hospital. Since that time it was believed not to exist in this country, but scattered cases have undoubtedly occurred, and have been mistaken for typhoid. In 1910, Brill observed certain atypical cases of what was supposed to be typhoid fever in New York, and this condition was known for some years as Brill's disease. It has been conclusively shown that this was really typhus because animals inoculated with Brill's disease are immune to typhus.

It seems unnecessary to say that the prevention of typhus fever consists in the eradication of lice. The subject is of little importance to people in the United States, many of whom have never seen a louse. But this insect is still present among people living in congested districts of large cities, and, it is well to remember that travelers often see them in other countries, and sometimes acquire them. Lice may travel considerable distances when separated from the body. Murchison, a famous English physician, in 1844, cautioned against sitting on the beds of typhus patients. There is a case on record where a judge contracted typhus from a prisoner under trial. This was formerly regarded as proof that the disease was air borne, but we now know that an infected louse travelled from the prisoner to the judge. When moving among people who are heavily infested as may

easily happen in certain parts of Mexico, Russia and other countries, it is almost impossible to avoid picking up these disgusting insects.

Lice are very easily eradicated. The so-called body louse should more properly be called the clothing louse, a fact recognized in its zoological name, *Pediculus vestimenti*. It does not live on the body but in the folds and seams of the clothes, where it also lays its eggs. In order to find this louse the clothes must be searched. Both lice and nits are readily killed by boiling water, and the clothing louse cannot exist when the clothes are changed frequently and sent to a steam laundry, or washed at home in a boiler. Washing in cold water does not kill the eggs though it probably discourages the adults. The prevalence of this louse in parts of Europe is readily understood from the habit of certain peasants of sewing their clothes on for the winter.

Children often get head lice (*Pediculus capitis*) at school. This is no disgrace, but it is a disgrace to keep them. They may be removed by soaking the hair with a 2 per cent carbolic solution or with equal parts of vinegar and kerosene at night. The head is wrapped in a towel and the next morning washed with soap and water, and the hair combed with a finetoothed comb to remove the nits. Children in school should always wear the hair short.

Trench fever. This disease is so called because it was first recognized among soldiers in the trenches in the World War, and is also transmitted by lice. It seems strange that an entirely new disease should have been found at this late date, but any condition that could be transmitted by lice had an unexampled opportunity for spread at this time. Trench fever did not cause many deaths, but as the patient suffered a number of relapses, it produced a great deal of disability and invalidism. As a result a British Commission and an American Commission were appointed to study the disease. Briefly, it was found that the organism producing the disease was contained in the excreta of lice that had previously bitten a case of trench fever, and the disease was produced experimentally in volunteers by rubbing the excreta of such infected lice into the skin. The blood of a case of trench fever may infect lice as late as the seventy-ninth

day of the disease, and the organism undergoes a cycle of development in the louse which only becomes infective seven days after it has bitten. The organism producing the disease is not definitely known, but is probably a form of Rickettsia, closely related to the organism believed to produce typhus.

Relapsing fever is another disease transmitted by lice and some other insects. The disease is found in all parts of the world and has often prevailed in epidemic form. It was first observed in the United States in 1884 and was epidemic in New York and Philadelphia in 1869, but no epidemics have occurred since that date. The disease is caused by a spirochaete, a wavy unicellular organism that occurs in large numbers in the blood. This organism was discovered by Obermeier in 1869. Relapsing fever in Africa is a very similar disease caused by a closely related spirochaete, but is transmitted by the bite of a tick that lives in the cracks of houses and whose habits are much the same as those of the familiar bed bug.

The prevention of relapsing fever depends upon general cleanliness and the avoidance of lice and bed bugs. The disease has disappeared whenever such precautions are generally observed.

Ticks

In addition to relapsing fever in Africa, ticks are the transmitters of a number of other diseases both in animals and man. Ticks are responsible for the spread of Texas cattle fever. This disease is caused by a protozoon parasite (*Piroplasma*) that lives in the red blood corpuscles much like the malarial parasite, and can not only be transmitted from animal to animal by the bite of an infected tick, but the eggs of the tick are also infected so that every one of its numerous progeny may also transmit infection. The disease causes solution of the blood corpuscles and haemoglobinuria or haemoglobin in the urine, for which reason it is sometimes called "black water fever." Dogs sometimes contract this disease. Black water fever also occurs occasionally in man but as the result of heavy infections with the malarial parasite.

An interesting disease called Rocky Mountain spotted fever was first observed in the Bitter Root Valley in Montana, and has

remained confined to certain regions in Montana and Idaho. The disease is believed to exist in the gophers of this region, and ticks become infected from them and transmit the infection to man. It is a very serious illness with an average mortality of 75 per cent. Efforts have been made to eradicate this disease by exterminating ticks but this work is difficult, and has so far been unsuccessful, although the disease has not spread beyond the originally infected areas. Very recently a preventive vaccine has been prepared from the juice of infected ticks which has protected both experimental animals and man against this disease. Infected ticks were ground up with sterile sand and water and the liquid thus obtained was sterilized by carbolic acid and used as vaccine. Guinea pigs and monkeys treated with this vaccine remained well when they were infected with the disease, while others not so vaccinated, died. It is probable that the disease may be prevented by vaccinating lumbermen, sheep herders, and all other residents and vacationists in the badly infected regions.

DISEASES CONVEYED TO MAN FROM OTHER ANIMALS

Rabies

Of these diseases the most important is rabies or hydrophobia. Rabies is caused by a filterable virus at present unknown and which has never been cultivated. But certain minute bodies known as Negri bodies, named after the discoverer, an Italian scientist, Negri, are found in the cells of the brain in about 98 per cent of cases of the disease and are probably one phase in the development of the virus. This virus is present in the saliva of animals suffering from the disease and is inoculated by the bite of the infected animal. Rabies is generally transmitted to man by the bite of rabid dogs, though sometimes by the bite of rabid cats, wolves, skunks, and other wild animals. The virus so inoculated travels to the brain along the nerves, and the length of the incubation period of the disease depends upon the location of the bite, so that rabies develops from bites upon the face much faster than from bites upon the hand or leg. The severity of the

bite and the presence or absence of clothing that removes some of the saliva are also important factors. Thus rabies has developed in the human victim so soon as twelve days after the bite, but the average incubation period of about 500 recorded cases was seventy-two days. There are no symptoms during this incubation period. Rabies in man commonly begins with a painful spasm of the muscles concerned in swallowing, making it difficult or impossible to swallow water, hence the name of hydrophobia. This spasmodic tendency increases until even a current of air or a touch brings on this spasm of the muscles of the throat, which then spreads to other muscles in a general convulsion. There is great anxiety and often a form of maniacal excitement. Death results from paralysis of the respiration in two to four days, and the disease is uniformly fatal.

Rabies inspires such terror that people almost invariably lose their heads when bitten by a dog. This is unfortunate, because although the disease, when once developed is uniformly fatal, it may be prevented with great certainty by taking the inoculations called the Pasteur treatment. But although this treatment is successful, it is painful, requires a number of injections spaced over several weeks, and should not be taken unless needed. Since rabies can only be transmitted by a dog that is rabid, it is unnecessary to take any treatment if the dog is not rabid. Whether or not the dog that bit was rabid can be determined by *watching the dog. Therefore, the dog should never be killed.* It should be confined in a cage where it cannot bite others, if possible under the care of a competent veterinarian. Rabies is also uniformly fatal in the dog, and if the animal that bit had rabies, *it will die of that disease within a few days.* If the dog remains well for ten days, it did not have rabies, no treatment for rabies is necessary, and the dog may be released and the subject forgotten. Should the dog die during this period, it should be sent to the nearest laboratory for examination of the brain for Negri bodies. When the dog is allowed to die of rabies, the Negri bodies in the brain are larger and more readily found, which is an additional reason for not killing the dog. Should the dog have been killed during a moment of temporary insanity, the body should be sent

to the nearest public health laboratory for the same examination to determine the presence of Negri bodies in the brain. If you must kill the dog in spite of all advice, choke it to death or kill it with kindness, but do not shoot it in the head with a pistol. This will result in the destruction of the brain, and you will never know whether or not the dog was rabid, and to be on the safe side, will be compelled to take the Pasteur treatment whether you need it or not.

The Pasteur treatment must be taken:

1. In all cases in which the dog proved to be rabid.
2. In cases in which nothing is known of the dog, especially if cases of rabies have already occurred in the vicinity.

Should the dog be known and does not develop rabies in ten days, no treatment is necessary, other than the usual treatment of the wound which is given at once.

Commercial firms and boards of health prepare and furnish the material for antirabic inoculations. In case the treatment is to be given, it should be commenced as soon as possible.

Rabies can be easily eradicated by muzzling all known dogs and destroying all stray dogs. If muzzling were kept up for two years after the last case of rabies, the disease would disappear, and muzzling could then be discontinued until the introduction of a new case. The disease was stamped out of England in this manner. It has been impossible to enforce such regulations in the United States owing to the misguided activities of some people who think they love dogs. Every properly constituted person does love dogs. A good dog becomes a real member of the family. But we also love children, yet we do not hesitate to quarantine them for the good of other children, when they suffer from infectious diseases. The muzzling of dogs is just as much for the protection of our own dogs as for ourselves.

A protective inoculation for dogs in one injection has been prepared and is being sold, but its effect is at present problematical. All the evidence indicates that it affords some protection against the development of rabies, but that this protection is by no means complete and cannot be depended upon to the exclusion of a properly enforced muzzling ordinance, if we wish to eradicate rabies.

Malta fever

Malta fever is so called because the disease was first described in the island of Malta where the inhabitants used goats' milk.

The disease is caused by a very minute bacterium first called the *Bacillus melitensis*, one of the smallest of known bacteria, originally identified by Bruce, a British Army surgeon. The organism is found in the blood of cases of Malta fever and leaves the body in the urine and stools and in the milk. It may therefore be transmitted as are other intestinal diseases, but the disease is classified here because the usual method of transmission is through consumption of milk of goats. Large numbers of these animals become infected, and the disease is primarily an infection of goats. It causes little inconvenience to goats, but their udders become chronically infected so that to all intents and purposes they become healthy carriers of this organism, and man becomes infected by drinking their milk. The disease is relatively rare except where herds of goats are kept and should always be suspected when goats' milk is known to have been used. The British troops in Malta had 240 cases a year before 1906, but since that date when condensed milk only was supplied, the number of cases has steadily declined. Malta fever is present in Texas and other parts of the United States where goats are raised.

Malta fever is a form of undulant or relapsing fever, characterized by marked waves of remittent fever separated from one another by varying periods when symptoms are absent. The fever which is high, 103° to 104°F. is ushered in by headache, depression and muscular pains, sweats and insomnia. The first attack may last from two to six weeks. The temperature then falls and convalescence appears to be established, but for a long time thereafter the fever recurs at intervals, lasting about ten days, so that three or four months elapse before recovery.

This disease may be prevented by avoiding the use of goats' milk, or by sterilizing it if it is used. Herds of goats should be kept at a proper distance from all human habitations, since the dust contaminated with urine may also convey the disease. Those who care for goats should use special precautions to avoid

infection, such as keeping the hands away from the mouth until they have been carefully washed.

Infected goats, or human cases of Malta fever, may be diagnosed by an agglutination reaction. When the blood serum of a case is mixed in proper dilution with a culture of the Micrococcus melitensis, the organism becomes clumped or agglutinated by the immune substances developed in the blood of those infected. The organism is not so agglutinated by the blood serum of normal individuals. Infected goats should be slaughtered or at least be withdrawn from the herd and isolated to prevent the spread of the disease. Imported animals should be examined and infected animals should not be added to healthy herds.

Within the past two years it has become evident that a modified form of Malta fever is fairly widespread in the United States though comparatively few cases have been reported. This form of Malta fever is caused by the *Bacillus abortus*, the cause of infectious abortion of cattle. This organism has been known for many years, but it was only very recently found to be a first cousin of the *Bacillus melitensis*. This type of Malta fever is acquired by using raw milk from cows that have suffered from infectious abortion. Since many herds of cattle have been infected with this disease, human cases can probably only be avoided by more universal pasteurization of milk.

Foot and mouth disease

Foot and mouth disease is a disease of cattle caused by a filterable virus at present unknown, that may also be transmitted to man through milk, butter and cheese. The disease in man commences with chilly sensations, fever and discomfort in the mouth. Vesicles appear on the lips and in the mouth and throat, which rupture and leave small ulcers. The disease lasts from ten days to three weeks and recovery is the rule, though there may be a mortality of 8 per cent.

So far as milk is concerned, it is rendered safe by pasteurization, and butter and cheese could be made from such pasteurized milk, but no method is known of making butter and cheese made from raw milk of infected animals safe. Because of this

danger to man, every effort has been made to eliminate the disease among cattle in this country. There have been several epidemics in the United States. These have been controlled by identifying and slaughtering all infected animals. No other method is effective because the animals that recover remain capable of spreading the infection over long periods.

The Bureau of Animal Industry of the United States Department of Agriculture has been so very energetic in suppressing this disease among cattle, that we have no reason to fear it. But the next time the papers carry the news that a certain district is quarantined against foot and mouth disease, this brief account may cause a better appreciation of the vigilance and efforts of our Government officials to preserve the public health.

Milk sickness

Milk sickness in man is an intoxication caused by the use of milk, milk products or meat from animals suffering from trembles. Trembles is a very serious disease of cattle, sheep and other herbivorous animals in which the animal staggers, the entire muscular system trembles and death occurs sometimes in convulsions, and is an intoxication caused by eating a poisonous plant, *Eupatorium urticaefolium* (ageratoides), popularly known as white samicle, white snakeroot and richweed. This plant grows in shady places and thrives in hot weather when the grass is dried up, and cattle that are allowed to roam will eat it.

Milk sickness has become quite rare because with cultivation, clearing the land and fencing of pastures, cattle seldom have access to the poisonous plants.

In man, milk sickness begins with a loss of appetite, and fatigue, and later nausea and vomiting which may last for several days. Restlessness, irritability and convulsions may follow. There is obstinate constipation and a fetid odor to the breath is said to be characteristic. In the most acute form death occurs in two or three days, but other cases last several weeks.

The disease may be avoided by providing proper fenced pastures for cattle. Milk from any animal that appears ill should never be used or sold.

Glanders

Glanders is a disease of horses caused by infection with the *Bacillus mallei*, and characterized by a purulent discharge from the nostrils of the infected animal. The disease spreads rapidly among horses from infected watering troughs, and as it is uniformly fatal, great care is exercised to identify and kill all infected animals. As the result of these precautions, the disease is rarely seen among horses. Glanders may be communicated to man in whom it is also a uniformly fatal infection. But fortunately man is not especially susceptible and glanders in horses is suppressed to such an extent that cases occurring in man are medical curiosities. Very few doctors have ever seen such a case. But if glanders among horses were not controlled, the disease might be more common in man. All horses used in the Army are tested before purchase and at stated intervals for glanders. This is done by injecting a product made from the *Bacillus mallei*, called mallein, and also by blood examination. Mallein causes a local and febrile reaction in a horse infected with glanders but not in normal horses. The blood is examined by means of a complement fixation reaction. (See description of the Wassermann reaction.)

Trichinosis

The *Trichina spiralis* is a microscopic worm living within the muscle fibers of certain animals. The immature worm lives in these muscles for years, and never escapes until eaten by another animal. When so eaten, the young worms are liberated in the intestines where they become mature in five or six days. Each sexually mature female, of which there may be several hundred or more, depending upon the number of embryos swallowed, gives off between 1000 to 1500 embryos, which penetrate the intestinal wall and enter the lymphatics by which they are carried to the muscles. They penetrate the muscular fibers, become encysted there, and are ready to repeat the cycle. The invasion of the muscle fibers by this enormous number of microscopic worms causes intense muscular soreness, fever and general prostration. In addition to these symptoms, infestation with worms causes a

great increase in certain leucocytes (white blood cells) known as eosinophiles, which is easily detected by a blood examination; and in doubtful cases a bit of muscle tissue may be removed and examined for trichinae. There is no treatment for this condition, but most cases recover.

The worm is primarily a parasite of the rat, and is maintained in this animal because rats are cannibalistic and often eat each other. So far as man is concerned, the hog is the infected animal, because hogs will catch and eat rats. The hog thus acquires trichinae and man becomes infected when trichinous pork or ham is eaten raw. The obvious preventive measure is never to eat raw pork or ham. The worm is killed when meat is thoroughly cooked. No microscopic examination is now included in meat examinations, since hogs were found to be infected so rarely as to make the cost of this service all out of proportion to its value. It has been found that keeping meat frozen for twenty days also kills the worms, so that it is highly improbable that meat sold from any of the large packing houses will be infected. Nevertheless all pork should be well cooked.

Cestodes (tape worms)

There are several varieties of tape worms, the most important in the United States being the pork tape worm (*Taenia solium*) and the beef tape worm (*Taenia saginata*). The mature tape worm, which may be from 40 to 60 feet in length, has a head about the size of a pin head armed with suckers, and also in the pork tape worm with hooklets, by means of which it attaches itself to the intestinal wall. The body increases gradually in width up to the terminal portion of the worm which is about $\frac{1}{2}$ inch wide. The tape worm is composed of segments, each one of which is hermaphroditic, or sexually complete. Only the terminal segments are sexually mature, but as they become filled with many fulled developed eggs, these terminal segments are discharged in the stools. The segments are capable of independent wormlike motion, and when deposited upon the ground can wander about among the grass. If eaten by a pig or a cow (the pork tape worm can only develop in the pig, and the beef

tape worm only in the bovine species) each egg shell is dissolved in the stomach liberating an embryo with hooklets which bores its way through the body until it reaches the muscles. There it forms a cyst, which is called a cysticercus, and there it remains until the meat of such an animal is used for food. On reaching the intestine of man, each cysticercus develops into a mature tape worm and the life cycle is repeated. Such cysticerci in pork or beef can be seen readily on inspection, and meat so infected is called "measly."

These tape worms in man cause no serious disease, but often result in considerable gastro-intestinal disturbance. They may be removed by several well known anthelmintics. The entire worm must be brought away, for if the head remains, it will grow again.

The prevention of such infestation depends upon the proper disposal of excreta so that the ground does not become infected, and upon systematic meat inspection. Tape worms have become much less common since such meat inspection has been practiced in all large abbatoirs. But the country districts where they still kill their own hogs and cattle are precisely those districts where the least care is observed concerning disposal of bowel evacuations, so that in such places infestation with tape worms is still relatively common. When a present is received of some "fine country sausage" it is well to bear in mind the possibility of infection with trichinae and tape worm and to see that that particular sausage or ham is very thoroughly cooked.

Taenia echinococcus. This is a small tape worm infesting dogs. If the eggs of this tape worm are swallowed by man it enters the cysticercus stage, which in the case of this worm is very large, and may cause the development of tumor-like swellings in important organs such as the liver or brain. Such echinococcus cysts are found only in those who associate closely with dogs. Since dogs are prone to lick themselves and subsequently lick their friends and admirers, the possibility of such infection is always inherent in these caresses. No matter how fond we may be of dogs, it is certainly cleaner and possibly safer not to permit them to lick our faces.

INFECTIONS SPREAD THROUGH UNBROKEN SKIN OR THROUGH WOUNDS

Tetanus

Tetanus, or "lockjaw," is caused by the bacillus of tetanus, a rodshaped organism, which is commonly found in the intestinal tract of animals, particularly horses, and in the soil. Manure and ground that has been fertilized with manure usually contain large numbers of tetanus organisms, which form spores that can lie dormant in the soil for years and retain the power to germinate and multiply when they gain access to human or animal tissues. The tetanus bacillus is anaerobic, that is, cannot grow in the presence of oxygen. For this reason open cuts seldom cause tetanus even when the organisms are present, but tetanus or lockjaw frequently develops when the organism is inoculated in such a manner that air cannot enter the wound. Such wounds are nail punctures, gunshot wounds, or other punctured wounds. In such injuries the tetanus bacilli are carried into a relatively deep wound, and the closure of the wound excludes air. The organisms then multiply and produce a toxin, one of the strongest poisons known, a minute fraction of a drop being sufficient to kill a guinea pig. This toxin circulates in the blood and after from four to ten days, the usual incubation period, is absorbed by the cells in the spinal cord. When these cells are so poisoned they become highly irritable so that the slightest stimulus causes convulsions of the muscles. The muscles of the jaw are commonly the first to be affected, hence the name "lockjaw," but later all the muscles of the body become involved, and the violent convulsions so produced usually end in death from inability to breathe, or from exhaustion.

Although few diseases are more fatal than tetanus, it is very easy to prevent it from developing. All cases of punctured wounds, gunshot wounds, and extensive lacerations with the introduction of dirt require prompt surgical treatment, which usually consists in opening such wounds widely in order that they may be cleaned out and air admitted. This is followed by the injection of a small dose (500 units) of tetanus antitoxin. If

this is done, tetanus can be prevented with certainty, because even though tetanus bacilli remain in the wound, they fail to grow, or if they grow, the antitoxin neutralizes all of the toxin as fast as it is produced. If the antitoxin is not given at once, the results are not so good, because after several days a variable amount of toxin may have already been absorbed by the nervous system, and the damage may be done.

Tetanus was formerly very common as the result of Fourth of July celebrations, particularly following wounds produced by toy pistols. The wad of the cartridge entered the tissues, and caused a wound exceptionally favorable to the growth of the tetanus bacillus. As the result of a campaign of education for a safe and sane Fourth of July, and of more effective treatment of such wounds, the mortality from tetanus was cut down from 406 deaths in 1903 to 10 deaths in 1911. Tetanus organisms are frequently present in glue which is made from the hoofs of animals. For this reason court plaster should never be applied directly to cuts, and bunion pads or other protectors containing glue should never be placed over vaccinations. Tetanus has been known to occur from the use of such dressings. During the World War many of the wounded who had been lying on infected earth, and whose clothing so soiled was driven into wounds, developed tetanus. This became so serious a problem that later all wounded men were given an injection of tetanus antitoxin at the first aid station. After adopting this practice, tetanus ceased to occur among those who received antitoxin within twenty-four hours after being wounded.

Tetanus may develop at any time between one and twenty days after an untreated wound, but the average incubation period in fatal cases is about nine days. The longer the incubation period, the better the chance of recovery. After the disease has developed, it may sometimes be cured by the use of massive doses of antitoxin. This is the best method of treatment, but even so, many cases in which the spinal cord has been irreparably damaged, will die. It is far better to prevent the disease by proper surgical treatment of all punctured wounds, and by the prophylactic injection of tetanus antitoxin.

Septicaemia (blood poisoning)

Septicaemia often results from the introduction of pyogenic bacteria through wounds or injuries to the skin, but bacteria may gain access to the blood in many other ways also. Thus septicaemia may result from any local infection, such as a diseased tonsil, an infected heart valve, or an abscess.

The mere entrance of bacteria and other microörganisms into the blood does not produce what is usually known as septicaemia, for the organisms of typhoid, syphilis, relapsing fever, and many other diseases circulate in the blood at some stage in the disease. The term septicaemia is used to include only those cases in which pyogenic (pus-producing) organisms gain access to the blood in a more or less overwhelming infection.

There are two types of pyogenic organisms known as staphylococci and streptococci. The staphylococcus is the organism commonly responsible for local accumulations of pus, such as boils and abscesses. The streptococcus is responsible usually for more extensive inflammations, for erysipelas, and in the genital tract of women at childbirth it is responsible for that form of septicaemia known as puerperal fever. Thus both the staphylococcus and the streptococcus may cause septicaemia, but infection with the latter organism is more common.

The reaction of the body to pyogenic infection is known as inflammation. At first the arteries and veins contract and the flow of blood to the infected part becomes more rapid. Soon the vessels dilate, the blood flows more slowly than normal, and the white corpuscles (leucocytes) accumulate on the walls of the capillaries. By an amoeboid action, these leucocytes creep through interstices between the cells of the capillaries into the infected tissue. Blood fluids and red cells also pour through, and the tissue becomes swollen with this inflammatory exudate. The part is red and hot from the increased blood supply, painful because of pressure on the nerves, and may throb with each heart beat. The pain is greater when the part is dense and unyielding as in bone, teeth, and cartilaginous organs such as the nose and ear. The inflammatory process is the effort of the body to count-

eract the infection, and will continue as long as the infection is present. Poisonous substances are washed away by the increased blood flow and the leucocytes attack and devour the bacteria. The methods that favor this process hasten recovery. Hot applications act by hastening the flow of blood. Pus, being composed of dead leucocytes and tissue, is deleterious and should be evacuated. If pus is not formed, the inflammatory exudate becomes absorbed when the infecting organisms are destroyed.

If during the active stage of inflammation, bacteria in large numbers are poured into the blood stream, septicaemia occurs, and is characterized by irregular chills, fever and sweats, and by great prostration. These pus-producing bacteria do not reproduce and circulate indefinitely in the blood, but invariably originate from some wound or other infected focus. Patients suffering from septicaemia often recover provided the original infected area from which the bacteria are derived, receives proper surgical treatment at a sufficiently early period of the disease. Such infected areas must be either removed completely or be opened freely and the pus drained. In rare cases amputation is necessary to remove the infection and preserve life.

The prevention of infection consists in the proper treatment of all local injuries. Infection of minor cuts and scratches may commonly be avoided by painting them at once, or after cleansing with soap and water, with tincture of iodine which can be obtained at any drugstore, and should always be kept on hand. Should any infection occur, it should be treated promptly by a competent physician and not ignored. It is probably only one such case in a thousand which will develop into septicaemia, but there is no use in taking even this chance. Infected tonsils, and appendices were formerly more often the causes of septicaemia than they are today when such infected foci are being removed in all hospitals.

Boils are caused by the infection of the skin by the staphylococcus. This organism is commonly found on the skin, and it is probable that boils develop only when some specially virulent organisms are deposited on the skin, or when for some reason the bodily resistance of the patient has been lowered. Boils should not be squeezed during the period of acute inflammation, as this

procedure favors the dissemination of bacteria and may even force them into the circulation thus producing septicaemia. When the boil has become soft and pus has accumulated, it should be freely opened and the pus removed, without using much pressure and exerting great care not to contaminate the surrounding skin thus giving rise to new infection of the skin and succeeding crops of boils. To prevent this, the skin should be washed with an antiseptic solution such as a one to one-thousand solution of bichloride of mercury or 2 per cent carbolic, and a wet dressing of this solution applied to the boil. In some cases when in spite of such precautions the patient suffers from a succession of boils, good results have been secured at times by the hypodermic injection of a staphylococcus vaccine. This is simply a suspension of the staphylococci in a saline solution to which sufficient carbolic acid has been added to kill all organisms. This increases the resistance of the patient to the infection by immunizing him with the organism that produces the disease.

Anthrax

Anthrax is another bacterial disease caused by the bacillus of anthrax which gains access to the body, usually through the skin, when it causes a very ugly sore known as malignant pustule. The anthrax bacillus is a spore-bearing organism which means that it is very difficult to kill and may remain dormant in the soil for months or perhaps years. Anthrax is primarily a disease of animals and is very fatal to all grazing animals. When the soil is infected by an animal having the disease, other animals grazing over the infected soil contract the disease readily and almost invariably die of anthrax. Animals that develop anthrax cannot be cured, but there is a protective inoculation that is used successfully to prevent the disease in regions where it is known to exist. When animals die of anthrax, no blood should ever be spilled on the ground, for the blood contains enormous numbers of anthrax bacilli, but their bodies should be burned in order to prevent infection of the soil.

Malignant pustule in man, while a serious infection, is not generally fatal but yields to good surgical treatment and to the

use of an immune serum that has been prepared against anthrax. Man becomes infected by handling the hides from infected animals, and it has therefore sometimes been called "wool sorters' disease." Another source of infection for man is the bristles in shaving brushes. A good shaving brush is made from bristles that have been properly sterilized before the process of manufacture. But during the war a number of cases of anthrax occurred among soldiers, and in practically every case, it was found that a new shaving brush had just been purchased. When traced back it was found that certain factories, during the press of war work had been making brushes from bristles which had been imported and which had not been properly sterilized. Cases of human anthrax are now comparatively rare owing to the prevention of anthrax in animals, the proper disposition of animals that do develop anthrax and sanitary regulations concerning tanneries and factories using hides or hair of animals.

Skin diseases

A number of skin diseases are caused by infection of the skin with various parasites, including scabies, ringworm and impetigo.

Scabies, commonly known as "the itch" and sometimes as the "seven-year itch" is caused by a mite named *Sarcoptes scabei*. Mites are commonly called insects but have eight legs while insects have six. Mites, ticks, and spiders are classified together under the name of Arachnidae. Arachne was a mythological woman who wove beautiful fabrics and challenged the goddess Minerva to a competition in weaving. The story goes that she beat Minerva, who in her anger at this defeat turned Arachne into a spider.

The mite causing scabies lives in the tunnels that it excavates in the epidermis, attacking by preference localities having thin skin such as the wrists, backs of the fingers, the abdomen and axillary folds.

These tunnels may be nearly half an inch long, and the female mite is at the end of the tunnel actively engaged in digging in and dropping eggs as she goes. When the eggs develop, the young mites begin independent tunnels of their own. It may easily be

imagined that this energetic process causes considerable irritation, and the itching of scabies for intensity and persistence, takes the prize. The mite is transmitted from man to man as the result of intimate bodily contact, or by sleeping in infected bedding or wearing infected clothing.

The itch was formerly all but universal, and is by no means eradicated at the present time. It is not infrequently seen in very cleanly people who travel in out of the way places where hotels are not very particular about their bed linen. The prejudice in favor of freshly laundered bed linen in hotels is thus readily explainable.

Sulphur ointment is a most effective treatment, but must be thoroughly applied. The patient should have a hot bath with plenty of soap, during which the burrows are opened up by scrubbing with a nail brush. After drying, a 10 per cent sulphur ointment is well rubbed into all parts. This treatment should be repeated several days. All clothing and bedding must be boiled.

Ringworm. There are a number of infections of the skin with parasitic fungi. Such fungi are closely related to ordinary moulds, and grow in the skin much as moulds grow on bread. They are, however, separate species and are strictly parasitic, so that infection can only be caused by association with another infected person or by infected bedding or clothing. There are many varieties of these parasitic fungi, each species causing a different skin disease. But in the United States, ringworm, caused by several species of Trichophyton, is the only common infection of this kind, and frequently occurs among children in school. It may affect the skin or the scalp. When the disease affects the scalp, the hair falls off, leaving small circular areas nearly bald. It causes a moderate amount of itching.

Ringworm infections are acquired by close personal contact with those infected, and are therefore much commoner among children. The spores of the fungus may also be transmitted in the clothing. The disease may be prevented by the isolation of cases until cured, avoidance of close contact with those infected, and the use of heat in laundrying clothes.

Ringworm of the skin is easily treated by painting with tincture

of iodine, or by the use of ointments containing salicylic acid, but ringworm of the scalp is very chronic, and such cases should be treated by a physician. Good results are now being secured by treating ringworm of the scalp by x-rays.

Impetigo is a skin disease, usually of children, characterized by pustules which appear on the face and neck, and occasionally on other parts of the body. The pustules break and run together forming superficial sores with yellowish brown crusts. The disease is caused by infection of the skin by bacteria, and is contagious so that children infect each other at play and in school, and by the use of common towels. The condition is not serious and is usually readily cured by proper treatment, but children so affected should be kept at home and treated by a physician until cured. If not properly treated the disease may be of long duration, and other members of the family may contract it.

Leprosy

This is a very old disease. We read of it in the Bible, and it was supposed to be widespread in Europe during the Middle Ages, when many hospitals called lazar houses were set aside for them. By the seventeenth century, leprosy had become rare; Louis XIV abolished lazar houses in France (1656–1662). It seems probable, however, that leprosy has never been so common as might be supposed from historical references, for there is good reason for believing that various ulcerative skin diseases, including syphilis, were confused with leprosy.

There is very little leprosy in Europe or the United States today, but it is fairly common in the Hawaiian Islands, the Philippines, India and some other tropical and Asiatic countries. There is a leper settlement on the island of Molokai where Hawaiian lepers are sent, and one on the island of Culion where lepers from the Philippine Islands have been segregated for a number of years. There are at present about 5000 lepers on the island of Culion, and perhaps another 5000 scattered among the approximately 10,000,000 population of the various islands, which means that about one out of each thousand of the population has leprosy.

Leprosy is caused by the *Bacillus leprae*, an organism much resembling the tubercle bacillus; it was discovered by Hansen in 1874. It is found in enormous numbers in the leprous nodules in the skin. But little is known concerning the method of transmission of leprosy. Many authorities believe that immediate contact with lepers is the usual mode of transmission, and this was the Biblical idea and the belief of the Middle Ages, when every effort was made to avoid contact with a leper. Lepers were compelled to wear a special gown and ring a bell to warn people of their approach. However, it is now known that there is little danger in such ordinary contact with a leper. Doctors and nurses in leper hospitals rarely contract the disease, and it is now admitted by all that intimate and prolonged contact with lepers is necessary to acquire the disease.

There are other facts that seem to indicate that leprosy is not transmitted by casual contact. Of 1000 lepers studied at Molokai, no history of previous association with lepers could be obtained in 56 per cent of the cases, and similar figures have been obtained in the Philippines. After all allowance has been made for the unreliability of such histories, it seems that a history of contact should be obtained more frequently if this is the usual method of transmission, especially as it is known that long contact is probably necessary.

There is some reason to believe that the disease is transmitted through the skin by cuts or insect bites. The first lesion of leprosy appears on an exposed part of the body in about 95 per cent of the cases, and the bacilli of leprosy have been found in mosquitoes and bedbugs, but it has not yet been shown that such insects can transmit the infection. Much more work is necessary to determine the precise method of transmission. The study of this disease is especially difficult because so far it has proven impossible to infect any animal with leprosy. We do know, however, that there is no cause for hysteria when a leper is found in some city. A leper is not nearly so dangerous as a case of advanced tuberculosis. Since leprosy is obviously transmitted in some way from those having the disease, lepers should be sent to a hospital for treatment and isolation; but since the infection is not readily transmitted, they need excite no alarm.

It has been known for many years that chaulmoogra oil, expressed from the seeds of a tree known as *Taraxtogenes kurzii* that grows in Assam, was an excellent remedy for leprosy if it could be taken, only it almost never could be taken regularly over long periods because it upset the stomach. All oils are composed of glycerin and a fatty acid. The glycerin is the same in all oils, but the fatty acids differ widely in chemical constitution. It therefore occurred to certain investigators that the fatty acids of chaulmoogra oil were probably the therapeutic principle of the oil. They therefore separated the fatty acids and combined them with ethyl alcohol (ordinary alcohol) forming what is known in chemistry as an ester. These ethyl esters of chaulmoogra oil are freely soluble and have been found to have a remarkable curative property when injected under the skin once a week. Many cases of early leprosy have been cured by this method both at Molokai and at Culion and in India, and have been permitted to return to their homes. Thus a disease, formerly believed to be incurable, has yielded to scientific methods of investigation, at least to the extent that certain cases are now curable and have been cured.

This introduces a new era in the control of leprosy. Formerly the only method available to eradicate the disease was to segregate the leper. This meant that lepers were concealed as long as possible to avoid such segregation, and on the average all lepers segregated had been at large for several years prior to segregation. Now that an effective treatment is available for leprosy, it is possible to establish local stations where the lepers will apply for treatment as soon as the disease is recognized, and only the incurable cases will require isolation in leper colonies. In a few more years it is probable that the number of lepers will be greatly decreased, and it may be hoped that this is another disease that in time may become completely eradicated.

Hookworm

This worm came into the limelight about twenty years ago when the newspapers called it the germ of laziness. It is a very small worm about half an inch in length which often occurs in

large numbers in the small intestine. The worm has a mouth formed for sucking and armed with hooks by which it attaches itself to the mucous membrane of the intestine and sucks blood. When large numbers of these worms (several thousand may be found) occur, the amount of blood lost is considerable, especially as the wounds so caused may continue to bleed after the worm has had a sufficiency. At any rate the continuous loss of blood results in a chronic drain producing a permanent reduction in the number of red blood corpuscles (anaemia). In adults this causes general weakness and debility, and children so infected may fail to grow. There are certain localities where hookworm disease or ankylostomiasis is very common, such as in Porto Rico, certain districts in the South of the United States and many tropical counties.

The method of transmission is especially interesting. The eggs of the worm are passed in the stools. When mixed with moist earth the eggs rapidly develop into small immature worms that may live a long time in such soil. When people walk barefoot over such infected soil, the worms bore through the skin of the feet causing what is known as "ground itch." These worms gain access to the blood and are carried to the lungs where they undergo further development and finally bore through the lungs to the interior of the bronchial tubes. From there they are coughed up and swallowed, reaching the intestine where they become adult worms and repeat the cycle.

Infestation with these worms may be prevented: (1) by always depositing faeces where contamination with the soil is impossible; (2) by always wearing shoes; (3) by treating all those who are infested.

Sanitary authorities are endeavoring to eradicate this disease by teaching proper methods of conservancy and by establishing public clinics where hookworm infestation may be diagnosed by the microscopic examination of the stools for eggs of the parasite and where all persons harboring the parasite may be treated. Several treatments are usually necessary to expel all worms. Children living in parts of the country where this worm is known to occur should not be permitted to go barefofoot.

VENERAL DISEASES; SPREAD CHIEFLY BY SEXUAL CONTACT

This class includes syphilis, gonorrhoea and chancroid.

Syphilis

Syphilis is one of the most interesting and important of all diseases. It is a very common disease though it could be completely eradicated; it causes a heavy mortality though seldom mentioned in mortality statistics; it is difficult to diagnose and always difficult to treat in spite of the fact that we have two specifics, mercury and arsphenamine (salvarsan).

The manifestations of syphilis are so diverse and often imitate other diseases so closely that the doctor who knows syphilis well is sure to be a good general diagnostician. Yet the classical picture of the disease is simple in the extreme. After the infection is received, there is an incubation period varying between fifteen and forty days before any sign of the disease appears. Then when the patient who does not know the disease supposes all danger of infection is past, the chancre appears at the site of inoculation. The chancre is a sore, or ulcer which is often but not always of a cartilaginous hardness. It is practically painless, and is often so slight as to escape notice, but when treated by local applications, refuses to heal. This sore may only last a short time, but usually lasts about five weeks and if it is very hard or indurated it may last much longer. This chancre is called the primary stage. Many diagnostic points were formerly taught to distinguish the primary sore or chancre of syphilis from the so-called soft sore or chancroid which is merely a local infection. It is now known that none of these diagnostic points can be depended upon with certainty and diagnosis is now made by repeated microscopic examination of the secretion from the sore, which is found to be teeming with the causative organisms (*Treponema pallidum*, a form of spirochaete) in most cases in which the sore is a chancre. In a microscope fitted with a dark field these organisms may be seen as actively moving, intensely illuminated spirals against a dark background.

During these weeks the sore appears to be quite a local affair, but by the time it has appeared the infection is already gen-

eralized, so that cutting out the sore cannot cure syphilis. The infection spreads along the lymphatic channels and soon the neighboring lymph glands enlarge, and the infection becomes generalized through the blood. About six weeks after the appearance of the chancre, this blood infection causes general symptoms which have been called the secondary stage. These symptoms include fever, malaise, aches and pains particularly of the bones, and a general skin eruption of red spots (macules), often described as of a copper color. Later, these macules may spread to the deeper layers of the skin, when they are called papules, and in some cases may even become pustular. This was more common formerly when the disease was often untreated, and gave rise to the vulgar name of "pox." The eruptions of syphilis seldom itch. In the mouth and other mucous surfaces the eruption assumes the form of white shallow ulcers called "mucous patches." These sores are full of spirochaetes and are very infectious. Infection may be innocently acquired by using drinking glasses, pipes or other objects that have been recently used by a syphilitic having such sores in his mouth. This explains the horror of the common drinking cup.

When untreated, the secondary stage may last months or years and gradually merges into the tertiary stage which is characterized by the formation of granulomatous tumors called gummas, that may occur in any organ, including skin, bones, brain, liver, etc. Later gummas soften and break down causing great destruction of tissue, and serious symptoms if in any vital organ like the brain, heart or liver. In the skin, large ulcers are produced. For some unknown reason, the nose is a favorite site for this ulceration. When the disease is properly treated these extensive lesions do not develop. Finally, still later, in a certain percentage of cases, the brain and spinal cord show evidences of the, by this time, long-standing syphilitic infection. When the spinal cord is so affected it causes the disease known as locomotor ataxia, and when the brain is affected it results in paresis or general paralysis of the insane.

The mortality due to syphilis is not realized because the term syphilis is seldom used in death certificates. But when it is

realized that many cases of insanity, apoplexy, heart and liver disease are really caused by syphilis, the effect on mortality begins to be appreciated. Many still births and deaths of infants under one year of age are due to congenital syphilis contracted from a syphilitic mother. Osler, in analyzing the statistics of the Registrar-General of Great Britain for 1915, estimated the number of deaths due to syphilis at 60,000, which placed it at the top of killing diseases, an easy first among the infections, ahead even of tuberculosis.

Syphilis is caused by the spirochaete known as the *Treponema pallidum*. In countries where families do not use individual eating utensils, or where a pipe is passed from person to person, there is considerable innocent syphilis (syphilis insontium), but in the United States from 90 to 95 per cent of all infections with syphilis are the direct result of sexual intercourse with infected persons. In the remaining cases, the extragenital infection is proven by the fact that the chancre is extragenital. Chancres of the lips and mouth are the most frequent of all extragenital chancres, and infection in these cases is contracted by promiscuous kissing and the introduction into the mouth of objects recently used by syphilitics. Doctors were frequently infected while making examinations in surgical and obstetrical work, with the development of a chancre on the finger. Since using rubber gloves, these infections have been much less frequent. Syphilis has been transmitted accidentally in a great variety of ways which are however comparatively rare. But although only from five to ten per cent of all syphilitic infections are acquired extragenitally, a much greater proportion of cases are innocent. "Syphilis is divided among husband and wife like the daily bread," and one of the partners, usually the wife, is innocent, and of course all cases of congenital syphilis are innocent. Since the disease is not limited to the guilty, we must regard it not as a logical punishment for error but as a social problem of prime importance.

The certain way to prevent not only syphilis, but other venereal diseases is the avoidance of all intercourse outside of the marital relation. It is to be hoped that through education of the kind

that develops character, this ideal may be measurably approached; but experience indicates that the moral progress of the race is slow. In the meantime and until people as a whole attain this moral plane, a certain number of infections can be prevented by the use of calomel ointment immediately after exposure. This ointment is composed of 33 per cent calomel in lanoline, and has been extensively used, especially in the military services, to prevent syphilitic infections.

The syphilitic lesions chiefly responsible for the conveyance of infection are the chancre and the secondary lesions, which are full of spirochaetes. Treatment with arsphenamine (salvarsan) heals these lesions very quickly so that they are no longer infectious. If all such early cases were properly diagnosed and treated, the prevalence of syphilis would be greatly reduced; and this is the best method of attacking the problem, because it results in great good, primarily to the patient, and secondarily to the community. The strictest moralist cannot object to such a method of controlling the disease.

Although one injection of arsphenamine may render the patient non-infectious, a long course of treatment with both arsphenamine and mercury is required to control the disease, or to produce a cure even in those cases that are treated in the primary stage. The reduction of the heavy mortality caused by syphilis depends not only upon reduction in the number of infections, but also upon persuading people of the necessity of early and intensive treatment of the disease.

Locomotor ataxia and paresis were formerly considered incurable. It is now known that cases of locomotor ataxia may be greatly improved by the proper administration of arsphenamine. Paresis has also been intensively studied during the past few years. It has been found that by the use of the drug tryparsamide, from a third to a half of the victims of paresis that have reached the stage of insanity may be restored to sanity. It has also been found that a high fever causes improvement in paretic cases, and a number of such cases have been treated by infecting them with malaria. After the malarial fever has lasted a sufficient time, the malarial infection is cured by the administration

of quinine. Great mental improvement has been reported in cases of paresis so treated. Both of these methods are as yet in the experimental stage, but hope is now afforded to a class of cases previously hopeless.

But before syphilis can be treated it must be diagnosed, and since the symptoms of syphilis often closely resemble those of other diseases, this diagnosis was formerly exceedingly difficult especially as so many patients denied or were honestly ignorant of the possibility that they had become infected. Many people, especially respectable married people would become indignant if they supposed the physician was even considering this diagnosis. Under these circumstances, the term syphilis was seldom used, but doctors spoke of lues, or more often of a "constitutional disease," or a "blood disease."

The diagnosis of syphilis was placed upon a much better footing by the development of the so-called Wassermann test, which would be more accurately named the complement fixation test for syphilis. In the study of immunity, it was found that an animal of one species, for instance a rabbit, could by successive intravenous injections, be immunized to the red blood cells of another species such as the sheep. Normal rabbit's serum will not dissolve sheep blood cells; but when the serum of a rabbit so immunized was mixed with the red blood cells of the sheep, these cells were promptly dissolved. A blood-dissolving or haemolytic substance was developed by the rabbit, and this substance was specific. That is, it would dissolve sheep blood cells, but not the blood cells of any other species. It was then found that if this immune rabbit's serum was heated to 55°C. this haemolytic action was destroyed, but that it could be restored by the addition of a little normal serum from any animal, for instance, the guinea pig. From this it may be seen that the solution of sheep cells could be brought about by the combination of two serums (heated immune rabbit's serum plus normal guinea-pig serum) neither of which were capable of producing haemolysis (solution of red blood cells) by themselves. From this it was learned that such haemolysis was dependent upon two factors: (1) an immune substance, not present normally, which was

specific, was not destroyed by heating, and which has been called haemolysin, and (2), a substance which is present normally in the blood of all species, but is destroyed by heating which was called complement because it complements the action of the haemolysin. That is:

Haemolysin for sheep cells + sheep cells = no haemolysis
Complement (guinea-pig serum) + sheep cells = no haemolysis
Haemolysin + complement + sheep cells = haemolysis

It was already known that if an animal were immunized to certain bacteria, for instance glanders, by the injection of dead glanders bacilli, something developed in the immunized animal's serum that dissolved the glanders bacilli and it was learned that this bacteriolytic action also depended upon the combined action of the specific immune substance produced (bacteriolysin) and complement or a substance present in all normal serum.

Now Bordet and Gengou wished to learn if the complement that took part in this bacteriolytic action was the same substance that took part in haemolytic action. They therefore devised this experiment. They mixed (1) heated serum of an animal immunized to glanders (bacteriolysin), (2) normal guinea pig serum (complement), (3) a suspension of glanders bacilli (called antigen). This was incubated for half an hour to permit the union of these three ingredients, and the solution of the bacteria. Then they added (4) heated serum immunized to red blood cells of the sheep (haemolysin) and (5) a suspension of red blood cells of the sheep.

Now, if the complement which assisted in the production of bacteriolysis was the same substance that assisted in the production of haemolysis, it would be used up (fixed) in the first part of the experiment, and consequently none would remain for the second half and no haemolysis would occur. Should the complements be separate, the first half of the experiment would not interfere with the second half and haemolysis would occur. It was found that the complement was the same in both cases, and that haemolysis never occurred when the complement had been first fixed by the bacteria.

This experiment was then reversed so as to be used as a di-

agnostic procedure. The same series was prepared with the exception that instead of using in (1) heated serum of an animal immunized to glanders, serum of a horse suspected of having glanders was used. Now if the animal had glanders, its blood would contain the immune body, and the complement would be fixed in its presence with the suspension of glanders bacilli, and the haemolysis would not occur when the haemolytic system (4 + 5) were subsequently added. If, on the other hand, the horse were normal, no immune substance to glanders would be present in its serum, and in this absence complement would not be fixed, and haemolysis would occur when the haemolytic system was subsequently added. We may here add that this is precisely what occurred, with the result that this complement fixation test for glanders is in constant use today for the early diagnosis of glanders. Glanders infection in horses may be detected by this method before the disease can be diagnosed by its symptoms, and the animal can then be killed before it has any opportunity to infect other horses.

Wassermann then argued that syphilis could be diagnosed in the same way, provided a suspension of the spirochaetes that cause syphilis were used as an antigen. But at this time the spirochaete causing syphilis (*Treponema pallidum*) had not yet been cultivated, and Wassermann was therefore unable to obtain a pure suspension of these spirochaetes. He therefore hit upon the expedient of using an emulsion of the liver of an infant that had died of syphilis at birth since it was known that such livers contained enormous numbers of spirochaetes. The test worked. That is, when an emulsion of syphilitic foetal liver (antigen) was added to the blood serum of a patient known to have syphilis, plus guinea pig serum (complement), this complement was fixed and haemolysis did not occur when haemolysin and sheep cells were added subsequently. On the other hand, if blood serum from an individual known not to have syphilis was used in the same way, haemolysis always occurred. After this test had been repeatedly subjected to severe experimental proof, it was introduced as a routine diagnostic procedure.

But it was soon found that alcoholic extracts of normal livers,

or of normal hearts, would produce precisely the same result as when an extract of syphilitic foetal liver was used as an antigen. It was found that the substances that cause fixation of complement in the presence of syphilitic serum are certain lipoids, or substances like fats in certain of their chemical characteristics. Therefore, this test is not a specific test in the same sense as is the complement fixation for glanders where a specific antigen (glanders bacilli) is used. How then can we be sure that a positive Wassermann reaction means that a patient has syphilis? There is no scientific proof in any individual case that a positive Wassermann means syphilis. Neither is there any scientific proof that the sun will arise tomorrow. We know the reason the sun rises, namely, because the earth revolves on its axis. It has always revolved, and we therefore believe that it will continue to so revolve. That is to say, experience is our only guide in this matter; but it is a sure guide and it is safe to say that the sun will continue to rise each morning on schedule time. In the same way we have an explanation of the mechanism of the Wassermann reaction, but in this case also experience is the guide. The real reason we think a positive Wassermann reaction, properly performed, indicates the existence of a syphilitic infection in the vast majority of cases is because this reaction has now been performed in hundreds of thousands of cases in laboratories all over the world, and the results of these reactions have been compared with the condition of the patient. It is positive in about 95 per cent of all cases of early secondary syphilis. In the later stages of syphilis it is positive much less frequently, the exact percentage depending largely upon whether the disease is active or latent. A positive Wassermann reaction is now accepted by medical men all over the world as probably the best single diagnostic sign of syphilis. It is not infallible and therefore must be used in conjunction with the usual medical study of the case. On the other hand, a negative Wassermann reaction cannot exclude the possibility of syphilis, because it is not positive in all cases of syphilis, particularly when the disease is of long standing (tertiary) or when the disease is latent (causing no symptoms).

Thus the Wassermann reaction is like any other symptom of a disease, it needs interpretation by a skillful physician. Nevertheless, it has been of the greatest value in identifying many cases of syphilitic infection in which the disease would otherwise not have been suspected.

With this facility in diagnosis, and with two specifics, mercury and arsphenamine, the treatment of syphilis is now on a very satisfactory basis. Many cases, especially when treatment is commenced in the primary stage are really cured, and it is possible to keep nearly all cases well and to prevent the infection of others. The positive Wassermann reaction is the last symptom to disappear under treatment and the first to reappear when treatment has ceased and the disease again becomes active. Therefore by having periodic Wassermann reactions made on his patient, the physician can tell when further treatment has become necessary to prevent the reappearance of other symptoms of the disease. Enough has been said on this point to show the great advantage of early diagnosis and treatment of syphilis, and the urgent necessity of consulting a competent physician immediately on the first appearance of any sore on the genitals, or concerning any sore on the lips, or other part of the body that does not heal within a reasonable time.

Although really satisfactory statistics are unobtainable, there is reason to believe that syphilitic infections are not quite as frequent as they used to be, and at any rate the disease is far better treated than was the case twenty-five or even ten years ago. The more people are educated to avoid infection, or to seek prompt treatment if infected, the less will be the prevalence of this totally unnecessary disease, and there will be a corresponding reduction of the heavy mortality directly and indirectly caused by it.

Gonorrhoea

Gonorrhoea is caused by a biscuit-shaped diplococcus, or bacterium known as the gonococcus. It causes a profuse purulent discharge. Urethral gonorrhoea in males is always acquired as the result of sexual intercourse with an infected individual, and

this is the usual cause in adult females. Gonorrhoeal ophthalmia is often acquired by touching the eyes with fingers soiled with urethral discharge, but may also be innocently acquired by the use of towels soiled with gonorrhoeal discharges and by other similar methods of indirect contact. Little girls often acquire gonorrhoea innocently by indirect contact, such as the use of sponges, and great care is necessary to prevent this infection in orphan asylums, children's hospitals and similar institutions where large numbers of little girls are cared for. If a single case is introduced, the disease may spread rapidly, and it is very difficult to treat.

Gonorrhoea develops rapidly after exposure, usually in from two to five days. It is a local disease, but the inflammation spreads by contiguity so that the bladder, ureters, and even the kidney may become infected. In the male the infection usually spreads also to the prostate gland and seminal vesicles and even the testicle in which case it often causes sterility. In the female it often extends to the uterus and Fallopian tubes. The inflammation so produced seals up the ends of these tubes, and pus then collects in them. These pus tubes require removal by an abdominal operation, and if bilateral produce sterility. In some cases a blood infection with the gonococcus occurs.

Contrary to more or less common opinion, gonorrhoea is therefore a serious infection resulting in much sickness and disability. Therefore, all cases of gonorrhoea should receive prompt and efficient treatment. Since the disease in adults is only acquired as the result of promiscuous relations, a word to the wise is all that is necessary on the subject of prophylaxis.

Children blind from birth owe this defect almost invariably to gonorrhoeal ophthalmia contracted during passage through an infected birth canal. Since doctors have applied silver nitrate solution routinely to all babies' eyes immediately after birth, congenital blindness has become quite rare.

Chancroid

Chancroid. This is a sore or ulcer caused by a bacillus named the bacillus of Ducrey after its discoverer. The disease is always

acquired by sexual intercourse with an infected individual, but the pus from the sores is auto-inoculable so that when the infection is once acquired, the sores may continue to develop. Several such sores commonly appear at the same time usually from one to five days after exposure. The disease is a local infection and causes no systemic symptoms. But the infection is prone to spread along the lymphatics to the inguinal lymph glands which suppurate, thus forming buboes, which must be opened and require a long time to heal, so that the infection may cause considerable disability. The main importance of chancroid is the necessity for a diagnosis between this infection and the primary sore of syphilis. This is frequently impossible from the history and physical examination, especially as both infections may have been acquired and may coexist. Therefore all such sores should be subjected to the microscopic examination with a dark field, already described, for the purpose of detecting the spirochaete causing syphilis if it is present. Wasserman reactions should also be made in all such cases, should the spirochaetes not be found, in order to detect a possible syphilitic infection at the earliest practicable time.

Chancroid is an infection that may be prevented in most instances simply by thorough washing with soap and water, since the infectious organisms are originally deposited on the surface of the skin and have no penetrative power. Chancroid, like gonorrhoea, may be avoided by abstaining from promiscuous sexual relations.

REFERENCES

(1) Rosenau: Preventive Medicine and Hygiene. Appleton & Co., 1922.
(2) Nichols, Henry J.: Carriers in Infectious Diseases. The Williams & Wilkins Co., Baltimore, 1922.
(3) Vedder: Syphilis and Public Health. Lea & Febiger, Philadelphia, 1918.

CHAPTER III

Nutrition and Nutritional Diseases

Nutrition is an interesting subject because we all have to eat. Those of us who eat to live are interested in the requirements of a proper dietary. Those of us who live to eat are anxious to learn how excess fat can be reduced by wearing rubber garments, using rubber rollers, or by taking some well-advertised quack remedy that guarantees reduction of fat without any departure from the accustomed plethoric diet; in other words, without interfering with our most popular indoor sport. This is like the case of the man who was directed to take one pill three times a day. It can't be done.

Most of the books on dietetics and nutrition written twenty years ago gave the impression that what we did not know about nutrition was hardly worth talking about. But great advances have been made in the study of nutrition since that time, and we might as well be modest and admit that we are yet only on the threshold of a scientific understanding of the subject.

DIET

Admitting this fact, there must be no delay in stating equally emphatically that for practical purposes, we know a great deal about diet. If people would only practise what the doctors preach, the real nutritional diseases would be prevented, and we should all weigh very nearly what we ought to weigh. An attempt will be made here to give a brief outline of what we have learned concerning nutrition, and the diseases that are produced by improper diet.

The body may be regarded as a living internal combustion engine. When fuel is supplied as food, it produces energy, part of which is expended in producing heat and part in performing work. This energy is obtained from the food as has been proven by placing animals and men in a calorimeter, or chamber so

constructed that the amount of heat produced by the subject and his gaseous interchange can be measured exactly. The first calorimeters were crude and only measured heat production, but by 1897, Atwater and Rosa succeeded in building a calorimeter of great sensitivity combined with a respiration apparatus which measured the amount of oxygen consumed and of carbon dioxide excreted by the man inside. These modern calorimeters are so sensitive that an increase in the amount of oxygen used, when the person inside merely raises an arm, can be measured. The heat generated by an electric current in the calorimeter, when measured, is precisely equivalent to the amount that may be computed mathematically. The amount of carbon dioxide recovered amounts to 99.9 per cent of its theoretical production. By means of this apparatus it has been possible to study the effect of starvation and of various foods upon the body.

Thus it has been shown that if a certain meal of fat and starch or sugar be fed to the experimental subject, it produces precisely the same amount of heat that it would produce if burned in a fire. Protein, or meat, produces more heat when burned than it does in the body, because it is not completely consumed in the body. When we burn anything, whether coal or sugar, the process is chemically one of oxidation. The carbon of the substance unites with oxygen to form carbon dioxide (CO_2) and the hydrogen to form water (H_2O), and as the result of this oxidation, heat is given off. Oxidation in the body is accomplished through the process of respiration. When we breathe, the body absorbs oxygen from the air and gives off carbon dioxide. A given amount of sugar or fat will combine with the same amount of oxygen and give off the same amount of carbon dioxide, whether it is burned in the fire or in the body.

This oxidation of food materials is performed by the cells of the body, and all of these cells are in constant state of chemical activity and change so that certain elements of food are appropriated for their repair or nutrition while certain other elements are excreted. This chemical change of materials by the body cells is called metabolism. The more rapid the metabolic process, the more oxygen is consumed and the more rapidly we must

breathe in order to obtain it. The colder the air and the more work we perform, the more fuel or food must be supplied to furnish the energy for heating the body and for work.

An ideal diet should be just sufficient to maintain normal metabolism, i.e., to supply the precise materials necessary for the repair of the tissues and for normal growth, and to produce a sufficient amount of energy. To continue the comparison to the internal combustion engine, an ideal diet should supply adequate fuel for the work to be performed and for new parts for the repair of the machine. The foods that we eat contain chemical constituents classified as proteins, fats, carbohydrates (starches and sugars), inorganic salts, vitamines and water. How is the total amount of these chemical substances that must be supplied to maintain normal metabolism determined?

BASAL METABOLISM

We begin the solution of this problem by determining the precise amount of energy expended by an individual in twenty-four hours. Energy is required for the maintenance of the body temperature, for work and even for the digestion of food. It is evident that the energy required will vary greatly with circumstances. But if a man is placed in a calorimeter at absolute rest, at a fixed temperature and without food, we may determine the absolute minimum of energy dissipated as heat by the human body. This is called the basal metabolism. In accordance with such observations the basal requirement of a 156-pound normal man for a priod of twenty-four hours is about as follows:

Absolute rest in bed without food	1680 calories[1]
Absolute rest in bed with food	1840 calories

The basal requirement given above will vary with changes in weight, height, age, sex, and disease. The amount of heat dissipated from the body bears a close relation to the extent of the body surface. All warm-blooded animals in starvation or on a

[1] A calory is the amount of heat required to raise one gram of water one degree Centrigrade. The large calory used in dietetics is the amount of heat necessary to raise one kilo of water at 20°C. through one degree centigrade.

medium diet and at a temperature of 18°C. (65°F.) give off the same quantity of heat for each square meter of surface. Therefore, of two individuals of equal weight, the taller one with the larger body surface expends the most heat. When the dimensions of a solid are doubled, the volume increases as the cube, but surface only as the square. Conversely, the smaller the body of an individual, the greater is the proportional surface area, and the basal metabolism is correspondingly proportionally greater. Thus, children have a higher basal requirement in proportion to their weight than do adults.

TABLE 4

Basal metabolism during the first year of age (Talbot)

Month	1	2	3	4	5	6	7	8	9	10	11	12
Calories	500	600	660	710	750	800	820	850	880	900	910	920

Basal metabolism of a boy from one to fifteen years of age (Lusk)

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Calories	500	800	850	900	1000	1100	1150	1200	1250	1310	1380	1430	1450	1475	1525

Basal metabolism of men of various heights and weights (Lusk)

Height	5′	5′2″	5′4″	5′6″	5′8″	5′10″	6′	6′2″	6′4″
Weight in pounds	128	132	138	146	155	165	176	189	201
Calories	1500	1550	1610	1700	1760	1850	1950	2030	2150

Basal metabolism of women of various heights and weights (Lusk)

Height	4′8″	4′10″	5′	5′2″	5′4″	5′6″	5′8″	5′10″	6′
Weight in pounds	115	119	123	127	134	142	150	157	163
Calories	1250	1300	1330	1400	1480	1540	1620	1680	1730

The body surface is relatively greater in thin people than in fat. Moreover, fat is tissue whose metabolism is very sluggish, for it is simply a reserve food supply and takes no part in the chemical changes of the body. For both of these reasons a very stout person would have a low basal requirement in proportion to his or her weight. Fat people, therefore, actually require less food than thin people, weight for weight. It is owing to a failure to recognize this fact that fat people become fatter although, as they say, "They eat no more than anyone else." They should

actually be eating much less than thin people. The basal requirement of women is about 7 per cent less than that of men of the same weight, probably because, as a general rule, they have more fat.

TABLE 5

Table for calculating surface area from the height and weight

HEIGHT	WEIGHT IN KILOGRAMS																
	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
cm.																	
200	.....	.....	.....	.....	.....	.....	1.84	1.91	1.97	2.03	2.09	2.15	2.21	2.26	2.31	2.36	2.41
195	.....	.....	.....	.....	.....	1.73	1.80	1.87	1.93	1.99	2.05	2.11	2.17	2.22	2.27	2.32	2.37
190	.....	.....	.....	1.56	1.63	1.70	1.77	1.84	1.90	1.96	2.02	2.08	2.13	2.18	2.23	2.28	2.33
185	.....	.....	.....	1.53	1.60	1.67	1.74	1.80	1.86	1.92	1.98	2.04	2.09	2.14	2.19	2.24	2.29
180	.....	.....	.....	1.49	1.57	1.64	1.71	1.77	1.83	1.89	1.95	2.00	2.05	2.10	2.15	2.20	2.25
175	1.19	1.28	1.36	1.46	1.53	1.60	1.67	1.73	1.79	1.85	1.91	1.96	2.01	2.06	2.11	2.16	2.21
170	1.17	1.26	1.34	1.43	1.50	1.57	1.63	1.69	1.75	1.81	1.86	1.91	1.96	2.01	2.06	2.11	.....
165	1.14	1.23	1.31	1.40	1.47	1.54	1.60	1.66	1.72	1.78	1.83	1.88	1.93	1.98	2.03	2.07	.....
160	1.12	1.21	1.29	1.37	1.44	1.50	1.56	1.62	1.68	1.73	1.78	1.83	1.88	1.93	1.98	.....	.....
155	1.09	1.18	1.26	1.33	1.40	1.46	1.52	1.58	1.64	1.69	1.74	1.79	1.84	1.89	.....	.....	.....
150	1.06	1.15	1.23	1.30	1.36	1.42	1.48	1.54	1.60	1.65	1.70	1.75	1.80	.....	.....	.....	.....
145	1.03	1.12	1.20	1.27	1.33	1.39	1.45	1.51	1.56	1.61	1.66	1.71	.....	.....	.....	.....	.....
140	1.00	1.09	1.17	1.24	1.30	1.36	1.42	1.47	1.52	1.57	.....	.....	.....	.....	.....	.....	.....
135	0.97	1.06	1.14	1.20	1.26	1.32	1.38	1.43	1.48	.....	.....	.....	.....	.....	.....	.....	.....
130	0.95	1.04	1.11	1.17	1.23	1.29	1.35	1.40	.....	.....	.....	.....	.....	.....	.....	.....	.....
125	0.93	1.01	1.08	1.14	1.20	1.26	1.31	1.36	.....	.....	.....	.....	.....	.....	.....	.....	.....
120	0.91	0.98	1.04	1.10	1.16	1.22	1.27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE 6

Calories per square meter of body surface per hour (Du Bois)

AGE	MALE	FEMALE	AGE	MALE	FEMALE
years			*years*		
14–16	46.0	43.0	45–50	38.5	36.0
16–18	43.0	41.0	50–60	37.5	35.0
18–20	41.0	38.0	60–70	36.5	34.0
20–30	39.5	37.0	70–80	35.5	33.0
30–40	39.5	36.5			

With advancing age, the oxidative process becomes slower, and basal metabolism is proportionately reduced. It is also clear that the basal requirement will change in a disease causing fever or in which tissue changes are increased or diminished. A quite elaborate study of the basal requirement in various diseases has been made in recent years, with the result that we now have

a scientific basis for prescribing a diet for those diseases, where before we made bad guesses at how much food was required.

TABLE 7

Requirement in calories per day of men of various heights and weights in various industrial pursuits

Height	5′	5′2″	5′4″	5′6″	5′8″	5′10″	6′	6′2″	6′4″
Weight in pounds	128	132	138	146	155	165	176	189	201
Basal metabolism	1500	1550	1610	1700	1760	1850	1950	2030	2150
Tailors	1950	2000	2100	2160	2230	2310	2410	2510	2610
Carpenters	2900	3000	3020	3100	3200	3300	3400	3500	3600
Stone masons	4000	4100	4150	4200	4300	4400	4500	4600	4700
Sawing wood	4600	4700	4750	4800	4900	5000	5100	5200	5300

TABLE 8

Metabolism in calories per day of women in various industrial pursuits

Height	4′8″	4′10″	5′	5′2″	5′4″	5′6″	5′8″	5′10″	6′
Weight in pounds	115	119	123	127	134	142	150	157	163
Basal metabolism	1250	1300	1330	1400	1480	1540	1620	1680	1730
Seamstress	1400	1430	1500	1550	1630	1700	1790	1840	1900
Typist	1500	1570	1630	1700	1780	1850	1920	2000	2050
Seamstress, sewing machine	1770	1820	1900	1950	2020	2100	2200	2250	2310
Housemaid, moderate work	1970	2030	2080	2150	2210	2300	2400	2430	2500
Laundress, moderate work	2320	2380	2420	2500	2560	2630	2710	2790	2850
Housemaid, hard work	2570	2630	2700	2750	2830	2900	3000	3050	3100
Laundress, hard work	3250	3300	3340	3400	3500	3580	3630	3700	3780

TABLE 9

Caloric requirements of boys

	AGE										
	5	6	7	8	9	10	11	12	13	14	15
Very quiet	1500	1600	1725	1810	1870	1910	2010	2120	2200	2210	2310
Active	2000	2150	2300	2400	2500	2650	2710	2860	2900	2950	3100
Very active	3000	3250	3500	3700	3800	3950	4100	4300	4350	4400	4800

Typhoid fever patients in former years were practically starved and suffered from the effects of typhoid plus starvation. Today

when typhoid patients are given an amount of nourishment carefully calculated to supply the energy actually dissipated, they no longer have the drawn, emaciated face and limbs, and they do not have the appetite of a starving man when convalescing.

The results shown in table 4 are based upon specific observations copied from several authorities and indicate the fluctuation in basal metabolism with age, weight and sex.

Du Bois found that for all normal men studied who were under fifty years of age the average basal metabolism was 39.7 calories per square meter, per hour; 86 per cent of all cases are within 10 per cent of this average. The basal metabolism of any individual can therefore be calculated if the surface area is known. Du Bois has devised a formula for calculating surface area from the height and weight; and Sherman in his book "Chemistry of Food and Nutrition" gives the figures shown in table 5 which convert the different heights and weights into surface area in square meters in accordance with Du Bois's formula. From this table anyone can calculate their surface area.

By applying the surface area so obtained to table 6, furnished by Du Bois, the basal metabolism may be determined.

Now, after supplying this minimum basal requirement of energy, or the amount of heat actually dissipated at rest, an additional supply must be furnished, depending upon the amount of work performed. Lusk has estimated in table 7 the requirement in calories per day of men of various heights and weights engaged for eight hours in various industrial pursuits.

Table 8 gives the metabolism in calories per day of women engaged for eight hours in various industrial pursuits. From these tables we may conclude that for an ordinary day's work, the average man requires not far from 3000 calories daily, and the average woman about 2500. Fat people are generally indisposed to exercise, and if such individuals consume food to the extent of 3000 calories or more daily, they will continue to become fatter. On the other hand, the activity of children is incessant and proverbial. Gephart investigated the food consumption of more than 350 boys in a large boarding school. These boys consumed on an average 4350 calories of food at the table and also bought 650 additional calories at neighboring stores.

Lusk gives in table 9 the caloric requirements of boys. Boys between the age of thirteen to sixteen years, who indulge in athletic sports require from 4000 to 5000 calories daily. That is, they eat like an adult stone mason or lumberman, and most fathers of healthy boys will agree with that statement. The dietaries of boarding schools and colleges have failed to recognize this fact, and the result is that the pupils are either half-starved most of the time, or make up the deficiency from outside sources, often as cakes, candy, ice cream, and beverages. It is high time that those responsible for feeding growing and active children learned that they require more food than adults.

And now, having determined the amount of energy that must be supplied by our food, we are to discuss how that food is to be selected, and in what proportions the protein, fat, and carbohydrates are to be used.

Broadly speaking, fat and carbohydrate furnish energy, but are not concerned in tissue building, except when stored as fat. Protein forms tissue and also may furnish energy. But protein is an inefficient and very expensive fuel and in an ideal diet only sufficient protein should be furnished to replace daily wear and tear, leaving the energy to be supplied by fats and carbohydrates. How is this essential minimum of protein to be determined.

The absolute minimum of protein required for short periods of time has been determined by ascertaining how much protein is required to maintain nitrogenous equilibrium. Protein contains nitrogen, while fat and carbohydrate do not. Therefore, if the proteins in the food or of the body are broken down during the metabolic processes, the end products must appear as nitrogenous waste matters in the excreta.[2] The nitrogenous constituents of the excreta and particularly of the urine have been shown, by

[2] It has been determined that nitrogen is not eliminated from the lungs. The loss of nitrogen in the perspiration, hair and nails is infinitesmal. Voit fed a dog for fifty-eight days with 29 kgm. of meat containing 986 grams of nitrogen and recovered 982.8 grams of nitrogen in the excreta of the period. The nitrogen in the urine was 943.7 grams and in the feces 39.1 grams. The difference between the amount of nitrogen ingested and that recovered in the excreta was only 0.3 per cent, and over 95 per cent of the nitrogen ingested was recovered in the urine alone.

numerous experiments, to be proportional to the protein destruction in the body. Meat proteins contain about 1 gram of nitrogen to 6.25 grams of protein. We may, therefore, conclude that for every gram of nitrogen found in the excreta, 6.25 grams of protein have been broken down in the body. If protein nitrogen from the food is retained in the body, this can only be due to the construction of new protein tissue, and if more nitrogen is eliminated than is received in the food, body protein tissue must have been broken down. When the amount of nitrogen in the food is equal to the nitrogen in the excreta, the body is in a state of nitrogen equilibrium.

It has been shown that when sufficient fat and carbohydrate are furnished in the diet to supply the energy expended, the rate of protein metabolism is unaffected by muscular exertion. That is, an increase or decrease of muscular activity has very little effect upon the amount of nitrogenous products excreted in the urine. Important deductions may be drawn from this fact. The habit of feeding athletes at training tables on huge quantities of meat while forbidding sugar and candy, is totally unreasonable. Such athletes require only slightly more meat than any other men of similar age and weight, and sugar is the most efficient fuel that could be supplied to furnish the great amount of energy that they expend. This also explains the fact that Chinese coolies and European peasants have always performed an enormous amount of muscular work with a very ordinary allowance of protein food. On the other hand, a rapidly growing child requires far more protein food than an adult, because such a child is building protein tissues rapidly, while in the adult the period of construction is over and protein is only required to supply the needs of normal metabolism.

With these facts, which have been demonstrated in many experiments on animals and men, it has been possible to determine the smallest amount of protein that will maintain nitrogen equilibrium for short periods. We say for short periods because it has been obviously impossible to continue experiments of this character over more than a few months. It has been assumed that if a certain supply of protein would maintain the nitrogen

balance for a few months, that it would continue to do so over a long period. We shall see later there may be certain exceptions to this general conclusion.

Chittenden found that he could maintain his own nitrogen balance on a diet containing only about 40 grams[3] of protein, but he weighed only 128 pounds. He actually recommended about 60 grams. Voit's classical standard called for 118 grams of protein. This latter allowance however, was not determined by the nitrogen balance, but were figures obtained by Voit after averaging the protein metabolism of many laboring men, and simply showed what the average man was in the habit of consuming. Atwater recommended 100 grams for light work, 125 grams for medium, and 150 grams for hard muscular work.

We may conclude from these figures that 60 grams of protein per day is the minimum requirement for healthy men of average weight, and we may next ask, is it reasonable and safe to restrict protein food to this minimum?

The various proteins are built up from combinations of nineteen amino-acids and, each body protein has a specific arrangement of these amino-acids. A protein may therefore be likened to a wall built with bricks of nineteen different shapes in a particular design. By pulling the wall down, the bricks may be reassembled in such a manner as to show many different designs. When protein is digested, it is split up into these amino-acids, which are used as building stones for the specific cellular proteins of the body. Many of the proteins, particularly those of vegetable origin, are lacking in some of these nineteen amino-acids. Lysine, tryptophane, tyrosin, and cystine are especially necessary, and are completely lacking in certain vegetable proteins. Zein, a protein from maize, is lacking in glycocoll, tryptophane, and lysine. If zein is the only protein in the diet the animal dies of inanition even though the remainder of the diet be properly balanced. If tryptophane is added, life becomes possible but not growth, and the animal becomes stunted. Gliadin, a protein from wheat, is deficient in glycocoll and lysin. A young animal

[3] Thirty grams are approximately equivalent to 1 ounce. These figures are for dry proteins.

receiving only gliadin as a source of protein lives but ceases to grow. But normal growth is resumed when the missing amino-acids are added to the diet. Casein, a protein from milk, is lacking in cystine, and growth is impossible on this protein alone. In milk this deficiency is supplied by a second protein known as lactalbumin.

Proper metabolism of the proteins of the body can only occur when all of these important amino-acids are furnished in sufficient amount. It will be readily seen that if for any reason the food supply becomes restricted and the diet is limited to one or two vegetable proteins, that some of the important amino-acids may be lacking or be deficient in quantity. Rubner found that 1500 grams of white bread (3.3 pounds) contained 104.4 grams of protein, which would maintain a working man in nitrogenous equilibrium for short periods. Yet no one would claim that this was a proper diet, for the protein is limited to the proteins of wheat which are deficient in important amino-acids, and animals fed on wheat protein alone will fail to grow and if the diet is continued will die. For this, and other reasons, it appears that Voit's standard of 118 grams of protein, or Atwater's standard of 100 to 150 grams, is much safer, as a general rule, than Chittenden's 60 grams. It is also apparent that there should be a fairly wide variety in the proteins consumed, and it is important that part of the protein be supplied from meat, milk, and eggs, that is animal or "Grade A" proteins containing all of the nineteen amino-acids necessary to the building of the body proteins. We shall come back to this subject when we discuss pellagra.

ENERGY

Fat and carbohydrate must furnish most of the energy required by the body. For many years fat was considered simply as a fuel, although it was recognized that it was a most convenient source of energy and in addition possessed the property of sparing protein. Less protein is burned during starvation if the body is fat, because the fats are oxidized very readily. And, if meat and fat be eaten together, the quantity of meat necessary to establish nitrogen equilibrium is reduced.

But a few years ago it was found that animals failed to grow and later died when fed on a diet of purified proteins, starch and salts, and that growth was resumed when butter fat was added. Vegetable oils, such as olive oil, cottonseed oil, and cocoanut oil did not have this property. It was apparent that the action of these animal fats was not simply to supply energy or the vegetable fats would have served as well. It has since been conclusively demonstrated that most animal fats contain some substance essential to normal metabolism and this has been called "fat-soluble vitamine." This vitamine is also present in leafy vegetables. By using these as a source of this vitamine, it has been found that animals can grow to maturity on diets deprived of all fats.

TABLE 10

Energy yield of food constituents

	ACCORDING TO RUBNER	ACCORDING TO ATWATER
	calories	*calories*
1 gram protein yields	4.1	4.4
1 gram fat yields	9.3	9.4
1 gram carbohydrate yields	4.1	4.1

So we may conclude that although fats are not indispensable, the animal fats particularly are a very desirable addition to the diet, as a source of fat soluble vitamine, as a fuel, and as a flavoring ingredient. The optimum amount of fat cannot be determined experimentally, so we may accept Voit's classical standard of 56 grams daily, which was established on the basis of many observations of diets actually in use. Chittenden recommended 60 grams.

The remainder of the 3000 calories required by the average adult man must be furnished from carbohydrates, that is, starches and sugars.

The energy yield of the food constituents is as shown in table 10: Rubner's figures are most generally used, although it is probable that Atwater's figures are more accurate. The difference, however, is very slight. We are now in a position to calculate

the proportion and amount of the three food principles required to maintain normal metabolism in the average adult (see table 11).

INORGANIC SALTS

Although it has long been recognized that inorganic salts were of great importance in the metabolism of bones, blood and the tissues in general, comparatively little is known concerning the details of the bodily requirements.

The minimum amount of calcium (lime) required daily in order to maintain calcium equilibrium is unknown. Calcium salts are of especial importance in the blood and bones. The proper level

TABLE 11

Proportion and amount of food principles required to maintain normal metabolism in the average adult

DIET	VOIT'S ESTIMATE
	calories
High protein diet:	
118 grams protein (× 4.1)	483
56 grams fat (× 9.3)	520
500 grams carbohydrates (× 4.1)	2050
	3053
Chittenden's low protein diet:	
60 grams protein (× 4.1)	246
60 grams fat (× 9.3)	558
500 grams carbohydrates (× 4.1)	2050
	2854

of calcium in the blood is maintained by the internal secretion of the parathyroid glands. When these glands are removed, the amount of calcium in the blood is greatly reduced and tetany, or tetanic contractions of the muscles occurs. Since life can only be maintained with a normal quantity of calcium salts in the blood, this amount is practically held constant so long as the parathyroid glands are normal, and any deficiency of calcium intake is manifested by abnormalities in the bony structures. A certain amount of calcium is required daily to replace wear and tear on the bones and teeth, and growing children require additional amounts for the formation of the rapidly growing bones.

Bone ash consists of almost 900 parts per thousand or 90 per cent of calcium phosphate. We do not know precisely how much calcium is required to replace this daily wear and tear of the skeleton, but a fasting man studied by Benedict eliminated 1.138 gram of calcium oxide in his urine on the thirty-first day of his fast. Calcium salts are excreted in the urine even when there is an insufficiency of calcium in the diet, and such individuals lose calcium from the skeletal structures. Pregnancy and lactation especially increase the demands for calcium to supply the growing organism. Failure to supply the calcium leads to rapid decay of the teeth and weakening of the skeleton. The disease osteomalacia or softening of the bones is undoubtedly caused by some as yet unknown disturbance of calcium metabolism. In rickets also calcium is not properly deposited in the bones, but in this case, the cause is now understood. Rickets is not caused by calcium deficiency but by inability to use the calcium supplied. It has been found that a man can be maintained in calcium equilibrium when the diet contains 0.4 to 1.5 gram of calcium oxide. For growing children and prospective mothers, the amount should probably be much larger.

Sodium chloride is an important constituent of all body fluids and tissue cells. From 10 to 15 grams of sodium chloride are excreted daily in the urine, but since the amount excreted depends primarily upon the amount of salt in the food, this gives no precise clue to the minimum amount required by the tissues. In cases of fasting the amount of sodium chloride which is derived from the body tissues is reduced to a mere trace.

Iron is an important constituent of haemoglobin, the coloring substance of the red corpuscles. Haemoglobin is the substance in the corpuscles which unites with the oxygen from the lungs and carries it to the body tissues. It is therefore the most important factor in internal respiration, and a deficiency in iron would be a very serious matter. Fortunately such a deficiency apparently only occurs as the result of certain diseases (the anaemias) for the supply of iron in the food appears to be ample under all ordinary circumstances. Hornemann places the requirement of calcium oxide at 1.7 grams, and of iron at 0.055,

and sodium chloride at 5 grams daily. In addition to these elements a certain amount of magnesium, potassium, phosphorus, and iodine is required. With the possible exception of iodine, we do not know the exact bodily requirements for any of these elements.

It has been generally assumed that any person consuming a mixed diet, conforming to other requirements already described,

TABLE 12

Ash content of the edible portion of some of our most used foods

	IN 100 GRAMS FRESH SUBSTANCE						
	Iron	Calcium	Magnesium	Sodium	Potassium	Phosphorus	Chlorin
	mgm.	*mgm.*	*mgm.*	*mgm.*	*mgm.*	*mgm.*	*mgm.*
Beefsteak	3.8	8	24	67	35	22	50
Eggs	3.0	67	9	15	14	16	100
Milk, whole	0.2	120	11	51	142	94	120
Cornmeal	1.1						
Oatmeal	3.7	93	127	81	380	380	35
Rice, polished	0.7	8	27	21	68	89	50
Wheat, flour	1.5	26	30	69	146	86	76
Wheat, entire grain	5.2	44	170	106	515	469	88
Beans, lima, fried	7.2	71	187	245	1743	336	25
Beans, string, fresh	1.6						
Cabbage	0.9	49	14	20	243	27	13
Corn, sweet	0.8						
Peas, dried	5.6	100	145	118	880	397	40
Potatoes	1.2	11	22	19	440	61	30
Spinach	3.8						
Turnips	0.6	64	169	59	332	51	40
Apples	0.3	10	8	15	125	13	4
Raisins	3.6	57	9	141	830	126	70

would obtain a sufficient supply of inorganic salts. This is undoubtedly true as a general rule, especially when the diet is sufficiently variegated, and includes plenty of milk, meat, and fresh vegetables. Milk, oatmeal, and beans furnish large amounts of calcium and this explains the desirability of an ample supply of milk to growing children and is one reason for the popularity of oatmeal. Meat, eggs, oatmeal, and green vegetables contain a large supply of iron. Table 12, which is copied from Lusk's

"Science of Nutrition" gives the ash content of the edible portion of some of our common and most used foods.

However, an ordinary diet does not necessarily protect from inorganic deficiency as a few illustrations will show. We have already referred to the fact that many women appear to suffer from a calcium deficiency during pregnancy as is evidenced by rapid decay of the teeth. Decay of the teeth is also common in children in whom the growing skeleton makes extraordinary demands for calcium. Such individuals should be provided with an unusual amount of calcium-containing foods, especially milk.

Kendall has shown that iodine is an important element, probably the most important element in thyroxin, the active principle of the secretion of the thyroid gland. The existence of endemic goitre in certain districts has long been known. Such districts include the mountainous regions of the Alps, Pyrenees, Carpathians, Himalayas, and the Andes. The United States also has goitre regions. Approximately half of the young girls in the public schools in the region of the Great Lakes show a detectable enlargement of the thyroid. It is noticeable that goitre regions are almost invariably far removed from the sea and it is from the waters of the ocean that our iodine is indirectly obtained. We have direct experimental evidence as to the importance of iodine in preventing thyroid enlargement. Marine and Kimball have found that sodium iodide in the dose 0.2 gram (3 grains) daily for ten consecutive days, and repeated each spring and autumn, prevents this enlargement of the thyroid.

It is probable that the amounts of iodine administered by Marine and Kimball in this experiment were larger than absolutely necessary. From 25 to 30 mgm. of iodine represents the total storage capacity of a normal thyroid gland, averaging about 0.2 per cent of the weight of the dried gland. It has been shown that as soon as the store of iodine falls to below 0.1 per cent of the dried weight, or to less than 12 to 15 mgm. of iodine, enlargement of the thyroid gland commences. But as this gland has a great affinity for iodine, it loses its iodine very slowly and hence very minute amounts only are necessary in the daily intake. More recent studies of the iodine content of foods and of the

amounts of iodine excreted by normal individuals and by individuals subject to goiter have shown that the daily requirement of iodine is very small indeed. The amount of iodine excreted by individuals of a town having no goiter averaged 0.064 mgm. daily, or 1.9 mgm. a month, while individuals of other towns suffering from goiter excreted only from 0.017 to 0.019 mgm. of iodine daily, or 0.57 mgm. monthly. Therefore, the difference between health and disease, so far as the excretion of iodine is concerned, is represented by 0.045 mgm. per day. Differences in the daily intake of 0.05 mgm. of potassium iodide, or 0.038 mgm. of iodine, may make the difference between health and the development of goiter.

Based upon the amount of iodine excreted in the urine in health, from 2 to 3 mgm. of iodine, or about 5 mgm. of potassium iodide each month, is an adequate dietary supply. It is a surprise to find that such infinitesimal amounts of any substance are important to the nutrition of the body, or it would be if we had not already learned the importance of such unconsidered trifles through the study of deficiency diseases caused by the deprivation of infinitesimal amounts of vitamines. The consideration of the amount of the various vitamines required to preserve health will be discussed under the deficiency diseases.

WATER

Water is eliminated from the body with the breath from the lungs, from the skin as invisible perspiration, and in the urine. The amount lost from the lungs does not vary greatly and is ordinarily about 2000 cc. daily. The amount of perspiration varies from 500 to 900 cc. depending upon temperature and exercise, and under certain circumstances these amounts may be doubled. The more water is lost through the skin, the less will be lost through the kidneys. The average amount of urine excreted daily varies between 1500 and 1800 cc. Excretion of water from the body therefore varies between 4000 and 5000 cc. daily (4.2 to 5.3 quarts). That means that this amount of water must be ingested daily, for water forms 67 per cent of the weight of the human body, and the removal of 5 or 6 per cent of this water, as

occurs in cholera, causes the blood to become viscid and flow slowly and no urine can be secreted. A large part of this water is taken with food, none of which is absolutely dry, while many foods contain as high a percentage of water as the body. The rest must be drunk as water or other beverages. The demand of the body for water is so imperative that normal thirst is usually a sufficient indication of the amount of water that must be taken. But it is probably true that many people do not drink sufficient water, and as a result their elimination through the kidneys is not as efficient as it should be. For the amount eliminated through the lungs and skin is a primary necessity for the regulation of the body temperature, and the total amount of water available for excretion through the kidneys, is only what remains after these demands have been satisfied. The habit of drinking plenty of water should therefore be established.

ROUGHAGE

While not a dietary requirement in the proper sense of the word, a certain amount of indigestible residue, which has been called roughage, is desirable in the food to provide a bulk upon which the intestinal muscles may obtain exercise. Lack of such a residue is one of the common causes of constipation. When rats are fed upon purified diets, it is found necessary to provide them with blotting paper for this purpose. In a well-balanced human dietary a sufficient amount of such roughage is furnished by cellulose and fibres from vegetables and fruits. Such articles as celery, green olives, and mushrooms, in addition to the flavors they impart, which stimulate the secretion of gastric juice, are comparatively indigestible, and are further valuable as sources of roughage.

With the exception of water the materials in our diet are derived directly from either vegetable or animal sources. Only plants possess the ability to synthesize food materials, such as protein and carbohydrates from the simple chemical elements found in the air and soil, and all animals depend on plants for these materials. When we eat beef we are only using plants second hand. The proteins and carbohydrates of the plant have

been converted into meat and fat by the cow. It has more recently been found that, with rare exceptions, animals are also dependent upon plants for the supply of those little understood substances, the vitamines, which, as a rule, cannot be synthesized in the animal body either.

DIETETIC VALUE OF FOODS

The dietetic value of our animal and vegetable foods has been determined by chemical analysis showing the proportion of protein, fat and carbohydrate in each food, as well as the number of calories produced by a given weight. Such values are given in table 13, taken from Atwater and Bryant, and including only a few ordinary foods. The complete table of chemical analyses of foods was published in Bulletin No. 28, United States Department of Agriculture, 1902.

In considering the food value of any article, not only the chemical constituents of the food as shown by such tables, but the digestibility, must be considered. The food eaten is digested and assimilated much better by some individuals than by others. As a general rule, the protein from vegetable sources is not so digestible as protein from animal sources. The manner of cooking is also important. The starch in a well-baked or boiled potato is much more available than in fried potatoes. Although such considerations appear to make the accurate selection of a proper diet difficult, such is by no means the case. Each person must be studied as an individual, and modifications made in the diet depending upon the power of digestion, habits of eating, etc. But in outlining a diet the general principles already described are followed, and the modifications are made only as observation and experience indicate.

Many tables have been prepared showing the size and weight of the various articles of food furnishing about 100 calories, together with the percentage of protein, fat and carbohydrate. One of the most useful of these tables was published by Professor Irving Fisher in an article on practical dietetics, and has been republished by the American Medical Association, Chicago, where it may be obtained at a cost of ten cents per copy. By

TABLE 13

Composition of ordinary food materials

KIND OF FOOD MATERIAL	EDIBLE PORTION						
			Available nutrients				
	Water	Unavailable nutrients	Protein	Fat	Carbohydrates	Ash	Fuel value per lb. = 453.6 grams
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
ANIMALS' FOODS:							
Beef (preserved and cooked):							
Dried and smoked	54.3	3.5	29.1	6.2		6.8	850
Flank, corned	49.9	2.7	14.2	31.4		2.2	1635
Canned, boiled	51.8	2.2	24.7	21.4		1.0	1415
Canned, corned	51.8	2.7	25.5	17.8		3.0	1275
Boiled beef (cut not given)	38.1	2.7	25.4	33.2		0.7	1930
Roast, cooked	48.2	2.4	21.6	27.2		1.0	1410
Loin, steak, cooked	54.8	2.0	22.8	19.4		0.9	1290
Lamb (cooked):							
Chops, broiled	47.6	2.5	21.0	28.4		1.0	1640
Leg, roast	67.1	1.4	19.1	12.1		0.6	905
Mutton (cooked and canned):							
Leg, roast	50.9	2.1	24.3	21.5		0.9	1410
Pork, (pickled, salted, and smoked):							
Bacon	18.8	4.8	9.6	64.0		3.3	2950
Ham	40.3	3.6	15.8	36.9		3.6	1905
Salt, fat	7.9	5.4	1.8	81.9		2.9	3565
Pigs' feet, pickled	68.2	1.4	15.8	14.1		0.7	920
Pork (cooked):							
Ribs, cooked	33.6	3.1	24.1	35.7		1.7	2020
Steak, cooked	33.2	3.3	19.3	43.1		1.1	2245
Sausage:							
Bologna	60.0	2.4	18.1	16.7	0.3	2.8	1085
Frankfort	57.2	2.3	19.0	17.7	1.1	2.6	1160
Pork	39.8	3.1	12.6	42.0	1.1	1.7	2080
Poultry and game (cooked and canned):							
Capon	59.9	1.7	26.2	10.9		1.0	995
Turkey, roast	67.5	1.3	17.1	10.9	0.8	2.4	855
Shell-fish (fresh):							
Round clams, in shell	86.2	0.9	6.3	0.4	4.2	2.0	215
Oysters, in shell	86.9	0.8	6.0	1.1	3.7	1.5	235
Crabs, hard shells	77.1	1.4	16.1	1.9	1.2	2.3	425
Lobster	79.2	1.1	15.9	1.7	0.4	1.7	400

TABLE 13—*Continued*

KIND OF FOOD MATERIAL	EDIBLE PORTION						
			Available nutrients				
	Water	Unavailable nutrients	Protein	Fat	Carbohydrates	Ash	Fuel value per lb. = 453.6 grams
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
ANIMAL FOODS—*continued:*							
Fish (preserved and canned):							
Cod, salt	53.5	6.8	20.9	0.3		18.5	430
Halibut, smoked	49.4	5.0	20.1	14.3		11.3	1015
Herring, smoked	34.6	5.2	35.8	15.0		9.9	1360
Mackerel, salt, dressed	43.4	5.0	16.8	25.1		9.7	1415
Salmon, canned	63.5	1.9	21.1	11.5		2.0	915
Sardines, canned	52.3	3.1	22.3	18.7		4.2	1250
Lobster, canned	77.8	1.3	17.6	1.0		1.9	400
Eggs:							
Eggs, boiled	73.2	1.2	12.8	11.4		0.6	755
Dairy products, etc.:							
Whole milk	87.0	0.5	3.2	3.8	5.0	0.5	310
Skimmed milk	90.5	0.3	3.3	0.3	5.1	0.5	170
Condensed milk, sweetened	26.9	1.2	8.5	7.9	54.1	1.4	1460
Cream	74.0	1.1	2.4	17.6	4.5	0.4	860
Cheese	34.2	3.4	25.1	32.0	2.4	2.9	1885
Butter	11.0	4.9	1.0	80.8		2.3	3410
Lard, cottolene, etc		5.0		95.0			3985
Miscellaneous:							
Gelatin	13.6	3.2	88.7	0.1		1.6	2125
VEGETABLE FOODS:							
Cereals, etc.:							
Corn (maize) preparations:							
Hominy, cooked	79.3	0.9	1.8	0.2	17.4	0.4	375
Oatmeal, boiled	84.5	0.9	2.3	0.5	11.3	0.5	285
Rice, boiled	72.5	1.1	2.3	0.1	23.8	0.2	505
Wheat preparations:							
Breakfast foods	9.6	4.5	9.3	1.6	74.0	1.0	1670
Macaroni, cooked	78.4	1.3	2.3	1.4	15.6	1.0	405
Bread:							
Brown	43.6	2.8	4.2	1.6	46.2	1.6	1035
Corn (johnnycake)	38.9	3.5	6.5	4.2	45.2	1.7	1170
Rye	35.7	3.4	7.3	0.5	52.0	1.1	1160
Graham	35.7	3.4	6.9	1.6	51.3	1.1	1185
Whole wheat	38.4	3.2	7.5	0.8	49.1	1.0	1125
White wheat	35.2	3.3	7.1	1.2	52.3	0.8	1195
Biscuit, soda	22.9	4.7	7.2	12.3	51.8	1.1	1655
Rolls	29.2	3.6	6.9	3.7	55.8	0.8	1360
Toasted bread	24.0	4.1	8.9	1.4	60.3	1.3	1390

TABLE 13—*Continued*

KIND OF FOOD MATERIAL	EDIBLE PORTION						
			Available nutrients				
	Water	Unavailable nutrients	Protein	Fat	Carbohydrates	Ash	Fuel value per lb. = 453.6 grams
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
VEGETABLE FOODS—*Continued:*							
Crackers:							
Milk, cream	6.8	5.0	7.5	10.9	68.5	1.3	1920
Graham	5.4	4.8	7.7	8.5	72.5	1.1	1900
Soda	5.9	4.9	7.6	8.2	71.8	1.6	1870
Cakes, cookies, etc.:							
Bakers (cake)	31.4	3.3	4.8	4.1	55.8	0.6	1335
Coffee cake	21.3	3.8	5.5	6.8	61.9	0.7	1580
Gingerbread	18.8	4.3	4.5	8.1	62.1	2.2	1620
Sponge cake	15.3	4.4	4.8	9.6	64.5	1.4	1735
Cup cake	16.6	4.5	5.9	13.2	59.2	0.6	1805
Molasses cookies	6.2	4.7	5.6	7.8	74.0	1.7	1855
Sugar cookies	8.3	4.5	5.4	9.2	71.6	1.0	1865
Ginger snaps	6.3	4.7	5.0	7.7	74.3	2.0	1845
Doughnuts	18.3	4.8	5.2	18.9	52.1	0.7	1895
Pie, pudding, etc.:							
Pie, apple	42.5	3.1	2.4	8.8	41.8	1.4	1215
Pie, custard	62.4	2.2	3.2	5.7	25.7	0.8	795
Pie, squash	64.2	2.4	3.4	7.6	21.4	1.0	800
Pudding, Indian meal	60.7	2.5	4.5	4.3	26.9	1.1	785
Pudding, rice custard	59.4	2.1	3 2	4 1	30.7	0.5	825
Pudding tapioca	64.5	1.0	2.8	2.9	28.2	0.6	715
Sugars, starches, etc.:							
Sugar, granulated					100.0		1790
Sugar, pulverized					100.0		1790
Sugar, brown					95.0		1700
Sugar, maple					82.8		1485
Molasses					70.0		1255
Maple syrup					71.0		1270
Vegetables:							
Asparagus, cooked	91.6	1.0	1.7	3.0	2.1	0.6	195
Beans, lima, green	68.5	2.7	5.3	0.6	21.6	1.3	525
Beans, string, cooked	95.3	0.5	0.6	1.0	1.9	0.7	90
Beans, baked	68.9	2.8	4.8	2.3	19.6	1.6	565
Beets, cooked	88.6	1.2	1.7	0.1	7.2	1.2	170
Beet "greens" cooked	89.5	1.2	1.7	3.1	3.2	1.3	220
Cabbage	91.5	0.7	1.2	0.3	5.5	0.8	140
Cauliflower	92.3	0.7	1.3	0.5	4.7	0.5	135

TABLE 13—*Continued*

KIND OF FOOD MATERIAL	EDIBLE PORTION						
	Water	Unavailable nutrients	Available nutrients				
			Protein	Fat	Carbohydrates	Ash	Fuel values per lb. = 453.6 grams
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
VEGETABLE FOODS—*continued:*							
Vegetables—continued:							
Celery	94.5	0 6	0 8	0.1	3.2	0.8	80
Cucumbers	95.4	0.4	0.6	0.2	3.0	0.4	75
Lettuce	94.7	0.5	0.9	0.3	2.9	0.7	85
Onions, fresh	87.6	0.8	1.2	0.3	9.6	0.5	215
Onions, cooked	91.2	0.8	0.9	1.6	4.8	0.7	175
Peas, green, cooked	73.8	2.5	5.1	3.1	14.4	1.1	490
Potatoes, cooked, boiled	75.5	1.7	1.9	0.1	20.0	0.8	415
Potatoes, mashed and creamed	75.1	2.0	2.0	2.7	17.1	1.1	475
Radishes	91.8	0.7	1.0	0.1	5.6	0.8	130
Spinach, cooked	89.8	1.1	1.6	3.7	2.7	1.1	235
Sweet potatoes, cooked	51.9	3.0	2.2	1.9	40.3	0.7	885
Tomatoes	94.3	0.4	0.7	0.4	3.8	0.4	100
Vegetables (canned):							
Asparagus	94.4	0.6	1.2	0.1	2.8	0.9	80
Beans, baked	68.9	2.7	4.8	2.3	19.7	1.6	555
Beans, string	93.7	0.7	0.8	0.1	3.7	1.0	90
Beans, lima	79.5	1.7	3.0	0.3	14.3	1.2	335
Sweet corn	76.1	1.7	2.1	1.1	18.3	0.7	430
Peas, green	85.3	1.4	2.7	0.2	9.6	0.8	235
Succotash	75.9	1.8	2.7	0.9	18.0	0.7	425
Tomatoes	94.0	0.5	0.9	0.2	3.9	0.5	100
Fruits, etc. (fresh):							
Apples	84.6	1.6	0.3	0.5	12.8	0.2	260
Apricots	85.0	1.5	0.9		12.2	0.4	240
Bananas	75.3	2.7	1.0	0.5	19.9	0.6	400
Blackberries	86.3	1.5	1.0	0.9	9.9	0.4	235
Cherries	80.9	2.0	0.8	0.7	15.1	0.5	320
Figs	79.1	2.2	1.2		17.0	0.5	330
Grapes	77.4	2.4	1.1	1.4	17.3	0.4	390
Huckleberries	81.9	2.0	0.5	0.5	14.9	0.2	300
Lemons	89.3	1.2	0.8	0.6	7.7	0.4	180
Muskmelons	89.5	1.1	0.5		8.4	0.5	160
Oranges	86.9	1.4	0.6	0.2	10.5	0.4	210
Pears	84.4	1.7	0.5	0.4	12.7	0.3	255
Plums	78.4	2.2	0.8		18.2	0.4	345

TABLE 13—*Concluded*

KIND OF FOOD MATERIAL	EDIBLE PORTION						
			Available nutrients				
	Water	Unavailable nutrients	Protein	Fat	Carbohydrates	Ash	Fuel value per lb. = 463.6 grams
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
VEGETABLE FOODS—*continued:*							
Fruits, etc. (fresh)—continued:							
Prunes	79.6	2.1	0.7		17.1	0.5	325
Raspberries, black	84.1	1.7	1.4	0.9	11.4	0.5	270
Strawberries	90.4	1.0	0.8	0.5	6.8	0.5	160
Watermelons	92.4	0.9	0.3	0.2	6.0	0.2	125
Fruits, etc. (dried):							
Citron	19.0	8.3	0.4	1.3	70.3	0.7	1340
Currants	17.2	8.6	1.9	1.5	67.0	3.8	1315
Dates	15.4	8.8	1.6	2.5	70.7	1.0	1415
Figs	18.8	8.7	3.4	0.3	67.0	1.8	1290
Raisins	14.6	9.1	2.0	3.0	68.7	2.6	1410
Fruits, etc. (canned):							
Apricots	81.4	1.9	0.7		15.7	0.3	295
Blackberries	40.0	6.1	0.6	1.9	50.9	0.5	1015
Blueberries	85.6	1.6	0.5	0.5	11.5	0.3	240
Cherries	77.2	2.3	0.9	0.1	19.1	0.4	365
Crab-apples	42.4	5.7	0.3	2.2	49.0	0.4	985
Peaches	88.1	1.3	0.5	0.1	9.8	0.2	190
Pears	81.1	1.9	0.3	0.3	16.2	0.2	310
Strawberries, (stewed)	74.8	2.6	0.5		21.7	0.4	400
Nuts:							
Almonds	4.8	10.9	17.8	49.4	15.6	1.5	2685
Butternuts	4.4	11.4	23.7	55.1	3.2	2.2	2805
Chestnuts (fresh)	45.0	5.9	5.3	4.9	37.9	1.0	990
Cocoanuts	14.1	9.2	4.8	45.5	25.1	1.3	2460
Filberts	3.7	10.7	13.3	58.8	11.7	1.8	2930
Hickorynuts	3.7	10.6	13.1	60.7	10.3	1.6	2980
Peanuts	9.2	10.7	21.9	34.7	22.0	1.5	2255

means of such tables the dietary requirements given above may be more readily translated into actual diets, and increases or decreases in the diet may be planned according to circumstances.

Suppose, for instance, we want a diet furnishing 2500 calories; such a diet is shown in table 14. By increasing the portions, this diet would easily furnish 3000 calories.

ALCOHOL

What place has alcohol in the diet? According to those who think the use of all alcoholic beverages is immoral, the question should not even be asked. On the other hand, the "wets" think that alcohol is a sovereign remedy for all the ills to which flesh

TABLE 14

Diets which easily furnish 3000 calories

	OUNCES	CALORIES
Breakfast		
1 large orange, or one large banana, or half grape fruit	9.4	100
Dish oatmeal with 1 teaspoonful sugar and cream	5.6	100
1 boiled egg	2.1	100
1 roll, ½ pat of butter	1.2	150
1 cup coffee, 2 small lumps sugar and cream	0.8	100
		550
Lunch		
2 eggs scrambled, or omelet, or 2 small lamb chops	2.0	200
1 helping macaroni, or one baked potato	3.85	100
1 small piece chocolate layer cake	1.00	100
Iced tea with lemon and sugar		100
		500
Dinner		
Soup—cream of celery, consomme or clam chowder	6.0	50
16 salted almonds or pecans	1.0	200
1 good helping roast beef	2.4	200
1 serving mashed potato	3.0	100
1 dish corn, or peas, or lima beans	3.4	100
2 slices bread, 1 pat butter, butter 0.4	2.6	300
1 piece lemon, custard, or apple pie and cheese	1.5	400
1 cup coffee, sugar and cream		100
		1450

is heir, from snake bite to bunions, and that it is an indispensable part of a daily ration. The belief in the specificity of large quantities of alcohol as a remedy for snake bite has killed more people in the United States than the snake bites themselves. It is well known that a quart of whiskey at a dose is sufficient to

kill almost any person, yet many victims of snake bite have been persuaded to gulp down such a dose by the friendly, but poorly informed bystander who attempted to render first aid.

No question has been so confused by propaganda as the use of alcohol, and arguments of all kinds concerning this question have generated far more heat than light; and it seems probable that many of them should have been conducted under the well known rules of the Marquis of Queensbury, since the ordinary rules of evidence and logic were ignored.

As an article of diet for healthy individuals, we may say at once that alcoholic beverages are totally unnecessary. So are coffee, tea, honey, oysters, and a host of other beverages and foods. But these things add to the joy of life, and so do alcoholic beverages when properly used. We therefore ask, is alcohol really a food, and secondly, is it harmful used in moderation? The first question is readily answered in the affirmative. Atwater and Benedict have proven that limited amounts of alcohol may be burned in the body in place of an equivalent amount of fat or carbohydrate. These investigators employed diets containing 2500 calories for a man at rest and 3500 for a man at work. Five hundred of these calories were supplied in 72 grams of alcohol, or about what is contained in a bottle of claret. This alcohol was given in six small doses, and 98 per cent was burned as fuel. The metabolism of the individual, as expressed in calories, was precisely the same as though an equivalent amount of carbohydrate had been consumed. (Lusk.) Alcohol is oxidized in the body and the energy thus furnished may supply heat to keep the body warm, and may aid in performing muscular work, and for these purposes may replace other nutrients. Alcohol is therefore a food. But it is a food of limited value for there is no evidence that it can become a part of organized tissue, whereas protein, fat and carbohydrate may do so, and besides it is not readily oxidized, and when used in any but small quantities, remains in the blood a long time, and then causes intoxication. It is therefore a dangerous food; but it is folly to claim that it is never a food or that it cannot be properly used.

Statistics of insurance companies have often been quoted as

showing that total abstainers live longer than even moderate drinkers. These statistics are fallacious for the reason that no one applying for a life insurance policy would admit that he was a hard drinker. Anyone that drinks at all is a moderate drinker for insurance purposes. More lately a careful statistical study by Pearl has shown that moderate drinkers live longer than total abstainers. This should not be taken to mean that moderate drinkers live longer because of their use of alcohol. But they live longer because the kind of a person who will be really moderate in the use of alcohol, will undoubtedly also be moderate in all his other habits of life. He will eat moderately, work moderately, and sleep moderately. In other words, he is a really sensible person who does nothing immoderately and hence lives longer than those having bad habits. We may, however, concede as the result of this investigation that the moderate use of alcohol is not harmful, and this corresponds with the fact that the people of France and Italy who habitually use wine moderately are apparently not injured by this custom.

Alcohol is a valuable food in certain diseases such as typhoid fever and diabetes, in which from the nature of the illness usual foods must be withdrawn or reduced greatly in amount.

There can also be no doubt that the abuse of alcohol, especially from a sociologic point of view is responsible for a great deal of damage. This is no place for a discussion of prohibition, and it is only intended to state here the place of alcohol as a dietary constituent in a reasonable way.

DISEASES CAUSED BY OVEREATING

It has been said that "we dig our graves with our teeth" and there is much truth in the statement, as is shown by life insurance statistics. A bulletin from the Metropolitan Insurance Company shows that after thirty-five years of age, overweight, even in relatively small amounts begins to be dangerous, and the danger increases with advancing age and the amount of overweight. Among men below 5 feet, 7 inches in height, at the age period forty to forty-four years, an excess of 20 per cent in weight carries an added mortality of 30 per cent above the normal. A 40 per cent

increase in weight carries an increased mortality of nearly 80 per cent. Among men over 5 feet 10 inches in height, at ages forty to forty-four, a 20 per cent excess in weight carries a 40 per cent increase in mortality, and a 40 per cent excess in weight doubles the mortality.

Underweight in early adult life is a disadvantage. Those who are 5 feet, 10 inches, and 20 per cent below the average weight have an increased mortality of 30 per cent. But from the age of forty on, underweight becomes a distinct advantage, and such underweights have the best mortality rates.

The tables for height and weight published by various authorities are the average weights for those heights and not by any means the best. At from twenty to twenty-four years, the lowest mortality rates are found in those whose weights are about 10 pounds above the average. At the age of thirty, the most favorable is among persons of average weight. After the age of thirty, the more favorable mortality rates are found among persons whose weights are below average. The amount below the average, giving optimum longevity, increases with advancing years, and at the age of fifty, individuals appear to be at their best when their weight is considerably below the average.

What this means, of course, is that most people after the age of thirty-five overeat and thereby become fat and throw an overload upon the blood vessels, liver, kidneys and heart. It is demonstrable that most people of this age eat too much because of the almost universal tendency to put on fat in middle life.

There is some reason to believe that over-consumption of starch and sugar predisposes to the development of diabetes and cirrhosis of the liver. The pancreas is the organ chiefly concerned in the digestion of carbohydrates, and carbohydrate can only be oxidized in the body through the action of insulin, the internal secretion of the pancreas. The liver converts glucose to glycogen or animal starch and acts as a storehouse for this carbohydrate. When these two organs are seriously overworked, degenerative processes often occur. When the pancreas is so affected, the disease produced is diabetes, and when the liver degenerates, the dead cells are replaced by fibrous tissue and we have the condi-

tion known as cirrhosis. It has long been known that overindulgence in alcohol was one of the causes of cirrhosis of the liver. Alcohol produces cirrhosis of the liver at least partly by overtasking that organ. But many people have developed cirrhosis of the liver who have never used alcohol in any form. There is a form of infantile cirrhosis of the liver quite common in India, which is believed to be caused by stuffing children with rice and sweetmeats, and it seems probable that long continued excessive consumption of carbohydrate foods will produce the same result as overindulgence in alcohol.

Nephritis has been produced in rabbits when various proteins were fed in large amounts. Later it was found that this damage to the kidneys was only produced in the absence of green food. When a little green food was also given, even very high protein feeding produced no deleterious effect upon the kidneys. This is in line with Stefansson's observation. This explorer lived on an exclusive meat diet for over nine years, during which period he reached his maximum weight and was in the best of health; and he affirms that continued high protein diets have no bad effect upon the Eskimos.

We know almost nothing concerning the longevity of the Eskimos or their diseases. Nevertheless all the evidence points to the conclusion that a high protein diet alone will not produce nephritis in man. But the case is far otherwise when organs are damaged by infections or other diseases. We know for instance that a damaged pancreas is made worse by functional overstrain, because if diabetics do not restrict their diet the disease is progressive and fatal, whereas by proper restriction, their lives may often be prolonged indefinitely. There is good evidence that the functional overstrain caused by a high protein diet acting upon an already damaged kidney is one of the causes of chronic nephritis.

OBESITY

Although there may be some question as to the injury caused by excess protein or excess carbohydrates to particular organs, we leave the realm of the hypothetical and enter the kingdom of

solid and obstinate fact when we deal with obesity. There is no doubt that obesity is prejudicial to both health and longevity, and it certainly reduces efficiency. Reduction in physical efficiency is self-evident, and in many cases it appears that the fat has gone to the head also. Shakespeare had noticed this, for he puts into Caesar's mouth the words "Let me have men about me that are fat; yon Cassius has a lean and hungry look; he thinks too much." Any real dictator would prefer men who are too indolent to think or act. But whatever may have been the case in Caesar's time, nobody loves a fat man now, and in this connection man embraces woman. A fat woman is out of style and women will endure any torment rather than this. Many women are making noble though frequently misdirected efforts to reduce, like the one who complained to her doctor that she had gained that week. Have you been taking my diet? Oh, yes, doctor. But what else have you eaten? Oh, nothing but my regular meals!

But granting the danger and the undesirability of obesity, the question is just what is obesity? When does a properly rounded figure pass the dead line of obesity? Tables of weights for various heights at different ages are a valuable help in determining obesity. Table 15 presents the average of many observations made by the Prudential Life Insurance Company.[4] Much has been written in recent years concerning the weight-height fallacy, and it must be granted that there is no fixed relation between the height and a proper weight. People differ in body type as much as do the thoroughbred racer and the Percheron draught horse. Some people are normally tall and slender and others are short and heavy without being at all obese. It must be clearly understood that the weights given are average weights and not ideal weights. The observations of the Metropolitan Insurance Company indicate that after the age of thirty-five, the most desirable weight in relation to longevity is considerably under these figures. But any considerable excess over these weights, unless caused by unusually large bones and muscles,

[4] Tice, "Practice of Medicine," Volume IX.

TABLE 15

Standard weight of men and women with shoes and clothes

Age	MEN																		WOMEN																	
	5 ft.	5 ft. 1 in.	5 ft. 2 in.	5 ft. 3 in.	5 ft. 4 in.	5 ft. 5 in.	5 ft. 6 in.	5 ft. 7 in.	5 ft. 8 in.	5 ft. 9 in.	5 ft. 10 in.	5 ft. 11 in.	6 ft.	6 ft. 1 in.	6 ft. 2 in.	6 ft. 3 in.	6 ft. 4 in.	6 ft. 5 in.		4 ft. 8 in.	4 ft. 9 in.	4 ft. 10 in.	4 ft. 11 in.	5 ft.	5 ft. 1 in.	5 ft. 2 in.	5 ft. 3 in.	5 ft. 4 in.	5 ft. 5 in.	5 ft. 6 in.	5 ft. 7 in.	5 ft. 8 in.	5 ft. 9 in.	5 ft. 10 in.	5 ft. 11 in.	6 ft.
15	107	109	112	115	118	122	126	130	134	138	142	147	152	157	162	167	172	177	15	101	103	105	106	107	109	112	115	118	122	126	130	134	138	142	147	152
16	109	111	114	117	120	124	128	132	136	140	144	149	154	159	164	169	174	179	16	102	104	106	108	109	111	114	117	120	124	128	132	136	139	143	148	153
17	111	113	116	119	122	126	130	134	138	142	146	151	156	161	166	171	176	181	17	103	105	107	109	111	113	116	119	122	125	129	133	137	140	144	149	154
18	113	115	118	121	124	128	132	136	140	144	148	153	158	163	168	173	178	183	18	104	106	108	110	112	114	117	120	123	126	130	134	138	141	145	150	155
19	115	117	120	123	126	130	134	138	142	146	150	155	160	165	170	175	180	185	19	105	107	109	111	113	115	118	121	124	127	131	135	139	142	146	151	155
20	117	119	122	125	128	132	136	140	144	148	152	156	161	166	171	176	181	186	20	106	108	110	112	114	116	119	122	125	128	132	136	140	143	147	151	156
21	118	120	123	126	130	134	138	141	145	149	153	157	162	167	172	177	182	187	21	107	109	111	113	115	117	120	123	126	129	133	137	141	144	148	152	156
22	119	121	124	127	131	135	139	142	146	150	154	158	163	168	173	178	183	188	22	107	109	111	113	115	117	120	123	126	129	133	137	141	145	149	153	157
23	120	122	125	128	132	136	140	143	147	151	155	159	164	169	175	180	185	190	23	108	110	112	114	116	118	121	124	127	130	134	138	142	146	150	153	157
24	121	123	126	129	133	137	141	144	148	152	156	160	165	171	177	182	187	192	24	109	111	113	115	117	119	121	124	127	130	134	138	142	146	150	154	158
25	122	124	126	129	133	137	141	145	149	153	157	162	167	173	179	184	189	194	25	109	111	113	115	117	119	121	124	128	131	135	139	143	147	151	154	158
26	123	125	127	130	134	138	142	146	150	154	158	163	168	174	180	186	191	196	26	110	112	114	116	118	120	122	125	128	131	135	139	143	147	151	155	159
27	124	126	128	131	134	138	142	146	150	154	158	163	169	175	181	187	192	197	27	110	112	114	116	118	120	122	125	129	132	136	140	144	148	152	155	159
28	125	127	129	132	135	139	143	147	151	155	159	164	170	176	182	188	193	198	28	111	113	115	117	119	121	123	126	130	133	137	141	145	149	153	156	160
29	126	128	130	133	136	140	144	148	152	156	160	165	171	177	183	189	194	199	29	111	113	115	117	119	121	123	126	130	133	137	141	145	149	153	156	160
30	126	128	130	133	136	140	144	148	152	156	161	166	172	178	184	190	196	201	30	112	114	116	118	120	122	124	127	131	134	138	142	146	150	154	157	161
31	127	129	131	134	137	141	145	149	153	157	162	167	173	179	185	191	197	202	31	113	115	117	119	121	123	125	128	132	135	139	143	147	151	154	157	161
32	127	129	131	134	137	141	145	149	154	158	163	168	174	180	186	192	198	203	32	113	115	117	119	121	123	125	128	132	136	140	144	148	152	155	158	162
33	127	129	131	134	137	141	145	149	154	159	164	169	175	181	187	193	199	204	33	114	116	118	120	122	124	126	129	133	137	141	145	149	153	156	159	162
34	128	130	132	135	138	142	146	150	155	160	165	170	176	182	188	194	200	206	34	115	117	119	121	123	125	127	130	134	138	142	146	150	154	157	160	163
35	128	130	132	135	138	142	146	150	155	160	165	170	176	182	189	195	201	207	35	115	117	119	121	123	125	127	130	134	138	142	146	150	154	157	160	163
36	129	131	133	136	139	143	147	151	156	161	166	171	177	183	190	196	202	208	36	116	118	120	122	124	126	128	131	135	139	143	147	151	155	158	161	164
37	129	131	133	136	140	144	148	152	157	162	167	172	178	184	191	197	203	209	37	116	118	120	122	124	126	129	132	136	140	144	148	152	156	159	162	165
38	130	132	134	137	140	144	148	152	157	162	167	173	179	185	192	198	204	210	38	117	119	121	123	125	127	130	133	137	141	145	149	153	157	160	163	166
39	130	132	134	137	140	144	148	152	157	162	167	173	179	185	192	199	205	211	39	118	120	122	124	126	128	131	134	138	142	146	150	154	158	161	164	167
40	131	133	135	138	141	145	149	153	158	163	168	174	180	186	193	200	206	212	40	119	121	123	125	127	129	132	135	138	142	146	150	154	158	161	164	167
41	131	133	135	138	141	145	149	153	158	163	168	174	180	186	193	200	207	213	41	120	122	124	126	128	130	133	136	139	143	147	151	155	159	162	165	168
42	132	134	136	139	142	146	150	154	159	164	169	175	181	187	194	201	208	214	42	120	122	124	126	128	130	133	136	139	143	147	151	155	159	162	166	169
43	132	134	136	139	142	146	150	154	159	164	169	175	181	187	194	201	208	214	43	121	123	125	127	129	131	134	137	140	144	148	152	156	160	163	167	170
44	133	135	137	140	143	147	151	155	160	165	170	176	182	188	195	202	209	215	44	122	124	126	128	130	132	135	138	141	145	149	153	157	161	164	168	171
45	133	135	137	140	143	147	151	155	160	165	170	176	182	188	195	202	209	215	45	122	124	126	128	130	132	135	138	141	145	149	153	157	161	164	168	171
46	134	136	138	141	144	148	152	156	161	166	171	177	183	189	196	203	210	216	46	123	125	127	129	131	133	136	139	142	146	150	154	158	162	165	169	172
47	134	136	138	141	144	148	152	156	161	166	171	177	183	190	197	204	211	217	47	123	125	127	129	131	133	136	139	142	146	151	155	159	163	166	170	173
48	134	136	138	141	144	148	152	156	161	166	171	177	183	190	197	204	211	217	48	124	126	128	130	132	134	137	140	143	147	152	156	160	164	167	171	174
49	134	136	138	141	144	148	152	156	161	166	171	177	183	190	197	204	211	217	49	124	126	128	130	132	134	137	140	143	147	152	156	161	165	168	172	175
50	134	136	138	141	144	148	152	156	161	166	171	177	183	190	197	204	211	217	50	125	127	129	131	133	135	138	141	144	148	152	156	161	165	169	173	176
51	135	137	139	142	145	149	153	157	162	167	172	178	184	191	198	205	212	218	51	125	127	129	131	133	135	138	141	144	148	152	157	162	166	170	174	177
52	135	137	139	142	145	149	153	157	162	167	172	178	184	191	198	205	212	218	52	125	127	129	131	133	135	138	141	144	148	152	157	162	166	170	174	177
53	135	137	139	142	145	149	153	157	162	167	172	178	184	191	198	205	212	218	53	125	127	129	131	133	135	138	141	144	148	152	157	162	166	170	174	177
54	135	137	139	142	145	149	153	158	163	168	173	178	184	191	198	205	212	219	54	125	127	129	131	133	135	138	141	144	148	153	158	163	167	171	174	177
55 and up	135	137	139	142	145	149	153	158	163	168	173	178	184	191	198	205	212	219	55 and up	125	127	129	131	133	135	138	141	144	148	153	158	163	167	171	174	177

may be termed obesity, especially when the waist measure exceeds that of the chest.

There are three grades of obesity. The first is merely a moderate increase over the weights just given, and if not progressive need excite no alarm. The second grade is funny. It appeals to our sense of the ludicrous when a man looks all around for the dog that is between his feet. The third grade is pathetic. Movement becomes difficult and is followed by shortness of breath and the individual is really an invalid.

WHAT IS THE CAUSE OF OBESITY?

Food consumed in excess of the body requirements is stored as fat, and the more fat is laid on, the less energy is expended, and the less food is needed. Therefore, after fat has once been deposited, it is laid on with increasing rapidity, although there may be no increase in the diet. Obesity is therefore caused by habitual overeating due to either ignorance or an undue fondness for eating. In some cases excessive amounts are not eaten, but the diet contains an unusual proportion of highly fattening foods.

Overeating is by far the commonest cause of obesity. In a few cases there is a disturbance in the internal secretions, particularly of the thyroid, as a result of which the basal metabolism is greatly lowered, and fat will be laid on even on a very much reduced diet. For this reason anyone contemplating reducing will do well to consult a physician and have a careful physical examination, including a study of their basal metabolism before going on a reduced diet. But such cases are the exception and not the rule. The great majority of fat people have no disturbance of metabolism.

But it is objected that in many cases a tendency to obesity is inherited. This is undoubtedly true. Some people remain thin in spite of eating excessively large quantities of food. These are often nervous people who are incessantly active and even sleep poorly, so that they expend an enormous amount of energy. In other cases there may be some fault in absorption so that the food eaten is not fully utilized. On the other hand is the person of sluggish temperament, who sleeps easily, and expends little

energy, yet has excellent powers of absorption. Every ounce of food is utilized. Persons inheriting this temperament with a good appetite are apt to become fat on diets that do not appear to be excessive. But in such cases it is to be noted, the fat is not inherited. They were not born fat, and usually begin to "swell wisibly" only after the age of thirty, although some are fat even as children. This fat is not generated out of nothing. It must come from the food even in those cases where such a tendency to obesity is inherited.

A marked hereditary tendency to become fat should call for a careful physical examination, including the glands of internal secretion, particularly the thyroid and the pituitary, to detect any abnormality. If no abnormality is found, the amount of food should be diminished until the weight is gradually reduced to that proper for the age and height.

It may be noted that nothing has been said concerning exercise and sweating as a method of reduction. Sweating removes only water; there is no oil in the sweat of the fattest individual. Therefore sweating does not reduce weight except momentarily and until the loss in water is made up by drinking. Turkish baths and vapor baths are therefore useless as a means of reducing weight.

Exercise undoubtedly expends energy and on a limited diet will assist reduction. Although it is thus theoretically possible to reduce weight on a fixed diet by increasing the exercise, very few fat people are capable of taking any such amounts of exercise. In addition exercise usually causes a violent appetite that cannot be restrained, and refuses to be satisfied with the reduced diet. Unless a person has an exceptional will power, no more than the customary amount of exercise should be taken on a reducing diet.

Advertisements are frequently seen emanating from some public benefactor who for a certain financial consideration, will be glad to send a remedy that will positively reduce the weight; the claim is often made that it is not even necessary to change the diet. Such remedies are either frauds, pure and simple, in which case the victim is no worse off except that he has been swindled; or they contain thyroid extract, which is a most dangerous drug

to take except with the advice and under the watchful care of a competent physician. The only cases where thyroid extract is beneficial are those in which the increased weight is caused by thyroid deficiency.

A reduction in diet is therefore imperative in the vast majority of cases if a reduction in weight is indicated. Nor is this such a difficult thing to do, because the normal appetite may be satisfied on much less than the usual amount of food provided a more suitable selection of food is made. The sense of satiety after meals is mainly caused by the distention of the stomach. If the stomach be skillfully filled with foods that are not fattening, a reducing diet may be both pleasant to take and quite satisfying.

In outlining such a diet, the first step is to determine the number of calories required daily for the proper weight (not the actual weight) and for the daily expenditure of energy at work. For this purpose the tables already given may be consulted, or caloric requirements may be calculated more simply, though not as accurately, by table 16.

The effect of a reduced diet should be watched by weighing daily or twice a week, and the process of weight reduction controlled by slight additions or decreases in the diet according to circumstances. A good working rule is to limit reductions to 5 pounds a month, so that a loss of 20 pounds would be spread over four months. With the very obese, the weight lost should not be more than 50 pounds per year.

How may these reductions be effected without decreasing the bulk of the diet? The fats and carbohydrates are the fattening elements of the diet, and must be reduced. Neither fats nor carbohydrates can be completely eliminated alone without danger of acidosis, for in some way, the utilization of these substances is related. It has been said that fats are burned in the fire of carbohydrate. This means that customary amounts of butter, cream, mayonnaise, pork, bacon and other fat meats and fried foods must be greatly reduced. Pastries and desserts which are made with fats and sugar must be eliminated. A single piece of pie may cost from 400 to 600 calories. Sugar should be greatly reduced and syrup, honey, preserves and candy should be elimi-

nated. The amount of bread, potatoes, cereals, macaroni, tapioca, cornstarch, dried peas, beans, corn and nuts should be moderately reduced. The protein consumed need not be altered unless excessive amounts have been eaten. It is possible to live on meat alone for a few months but no dietitian at present would recommend such a diet in spite of the testimony of polar explorers.

The reduced diet should therefore consist of lean meats, fish, fowl, eggs and cheese, with a small quantity of bread, cereals and

TABLE 16

A simple method of calculating caloric requirements

	CALORIES REQUIRED PER POUND OF BODY WEIGHT
At rest	11–14
At light work	16–18
At moderate work	18–20
At hard work	20–27

Examples: (1) A man whose proper weight should be 150 pounds actually weighs 170 pounds. He is employed at office work. How many calories should he consume daily in order to effect the desired reduction of 20 pounds? According to the table, at a weight of 150 pounds and with light work, about 2300 calories are sufficient. Multiplying 150 pounds by 16 equals 2400 calories. The desired reduction can be effected safely by reducing the diet to between 2300 and 2400 calories.

(2) A woman whose proper weight should be 120 pounds actually weighs 150 pounds. She does practically no work. She has been in the habit of consuming about 2500 calories per day. $120 \times 14 = 1680$. She should reduce her consumption of food to 1680 calories and as soon as she becomes accustomed to the change, should take moderate exercise. Should this not effect the reduction, the calculation may be made as $120 \times 11 = 1320$ calories.

In any case, reductions should be made gradually as sudden decreases in weight are deleterious.

potatoes, and the bulk may be made up by the addition of fruits and vegetables. By consulting the tables given it may be seen that many vegetables are very low in calories, but are valuable for other necessary ingredients including the vitamines.

The following vegetables contain only about 3 per cent of carbohydrate and are very low in calories; asparagus, cabbage, cauliflower, celery, cucumbers, eggplant, lettuce, onions, radishes, spinach, string beans, summer squash, tomatoes. These may

be eaten freely. Beets, carrots, green peas, okra, parsnips, pumpkin and turnips contain about 10 per cent of carbohydrate, and may be eaten comparatively freely. Practically all fruits except bananas may be eaten freely if sugar and cream are not used. Fruit sugar is the sweetest of all sugars. If the sweetness of cane sugar (sucrose) is rated at 100, fruit sugar (levulose) has a value of 173. The desire for sweets may therefore be gratified at the lowest possible intake of calories by eating fruit. Among the fruits, apples, berries, cantaloup, peaches, and watermelon are comparatively low in calories. The appetite may be satisfied by adding to the reduced diet a sufficient quantity of such fruits and vegetables. Further details concerning the diet suitable for each case should be obtained from the physician consulted.

UNDERNUTRITION

Comparatively few healthy adults are undernourished in the ordinary sense. A few are improperly nourished as the result of dietary fads in which category vegetarianism may be placed. There are very few strict vegetarians since most of them use milk, butter, cheese and eggs, and sufficient grade A animal proteins may be easily derived from such sources. It is theoretically possible to plan a strict vegetarian diet that will maintain health, but it requires a very wide assortment of vegetables to provide all the essentials of a perfect diet including a sufficient quantity of the proper kind of proteins. Strict vegetarianism is based upon sentiment or prejudice, has no scientific defense, and since the combined experience of the human race is against it, this diet will never become popular.

On the contrary, undernutrition among children is quite common, and attention has been directed to this condition by the physical examinations of school children which are being made more widely as the good results of such inspections become increasingly evident. There is the story of the child who complained because his teacher had marked his card "Poor nut." (poor nutrition).

In addition to the fact that children are often improperly fed either because of ignorance or poverty, there is the well known

fact that children often become overtired, and as a result lose their appetites and refuse their meals. This condition may be improved by restricting the activity of the child by periods of enforced rest. Candy should not be eaten by such children between meals because it spoils their appetite for other food, but should be given to them at dessert. The consumption of candy is not necessarily harmful as is so frequently taught, and should be an inalienable right of every child, in proper amounts and at proper times. The only way candy can hurt their teeth is by cracking or breaking the enamel through recklessly chewing hard candy. If soft candy is furnished this cannot happen.

Undernutrition in children has been frequently diagnosed by reference to standard height and weight tables. It has become increasingly apparent that this method is not satisfactory because perfectly normal children vary so widely in both height and weight according to their body type, which is hereditary. Some children who are apparently of normal weight are actually undernourished, but naturally the majority of undernourished children are underweight. The greater the degree of underweight for height, the greater is the probability that the child is undernourished. Thus in one examination of those who were 7 per cent underweight, 67.4 per cent were undernourished as shown by a subsequent examination by a physician, while of those 10 per cent underweight, 73.4 per cent were considered undernourished by the physician.

The best opinion at the present day is that diagnosis of undernutrition should be made only after a careful physical examination by a physician. In so estimating a child's nutrition, we must consider not only the ratio of weight to stature, but the general balance of the body, the firmness of the tissues, the presence or absence of subcutaneous fat, the state of development of the muscular system, the condition of the skin, and redness of the mucous membranes and the general attitude of alertness or listlessness. Such an examination will afford a far better estimate of general nutrition than mere measurements of weight and height. These considerations indicate that school inspections should be performed regularly by competent physicians, and it

is desirable that every child should be given such a careful physical examination once a year. This should include not only nutrition but the detection of such physical defects as imperfect vision, hearing, diseased tonsils, enlarged thyroids, and other physical and mental abnormalities.

DEFICIENCY DISEASES AND THE VITAMINES

The term vitamine was coined in 1912, but has already become very familiar. The general public is now in danger of being deceived by the half truths concerning vitamines contained in many advertisements of foods and alleged foods. Our knowledge of the vitamines has been derived from investigations of the conditions now known as deficiency diseases. It has become evident that there are several vitamines, and that the prolonged deprivation of any one of these vitamines results in the production of a characteristic disease. The most typical of these deficiency diseases are scurvy, beriberi, and rickets.

Scurvy

Scurvy is a disease characterized by anaemia, great weakness, and by a marked tendency to haemorrhages into various tissues together with changes in the bones resulting in softening and fragility. The basic abnormality in scurvy is the inability of the connective tissues either to produce or maintain intercellular cement substances. The decay of the teeth and bones is due to inability to form the bone matrix in which the lime salts are deposited, and the haemorrhages are caused by a lack of cement substance between the cells of the capillaries and smaller blood-vessels. Scurvy is therefore primarily a disease of the connective tissues. The disease is caused by the deprivation of the antiscorbutic vitamine which is present in many fresh fruits and fresh vegetables.

The earliest symptoms of scurvy are loss of weight, weakness and dizziness followed often by pains in the legs with muscular stiffness. Changes in the gums are one of the earliest and most frequent symptoms. The gums swell, become spongy, and bleed readily. This process becomes steadily worse until the gums ul-

cerate leaving the necks of the teeth bare, and the teeth may even fall out. Blood is poured out under the skin, where it coagulates and forms blotches which change in color like black and blue spots. Sometimes the blood is poured out into the muscles where it coagulates and forms painful swellings. The bones, particularly of the legs, become soft and spongy and there is a continuous aching of the bones, which break very easily. The teeth also become soft and fragile. Unless relief comes by a change in the diet, the patient dies, often very suddenly, as the result of a large haemorrhage or from heart failure

Scurvy is a very old disease but for many years its cause was not known. The history of the development of our knowledge concerning scurvy and the other deficiency diseases will show how the information concerning the vitamines was derived. Scurvy was probably first described by Joinville in the year 1260, and was unknown among sailors of ancient times because their voyages were all short. But when the art of navigation became improved and long voyages were made, scurvy promptly commenced to appear among the seamen. In the famous voyage of Vasco da Gama around the Cape of Good Hope in 1497, one hundred out of his one hundred and sixty men died of scurvy, and this disease remained the terror of seamen for several hundred years. In 1740, a squadron composed of five naval vessels sailed from England under the command of Commodore Anson for a cruise around the world. But one of these ships, the *Centurion*, and only 5 per cent of the personnel returned to England after an absence of four years. The majority of these men died of scurvy, as was shown by the diary kept by Richard Walter, from which the following may be quoted:

"Soon after passing straits le Maire, the scurvy began to make its appearance among us. And our long continuance at sea and the fatigue we underwent, and the various disappointments we met with had occasioned its spreading to such a degree that at the latter end of April there were but few on board who were not in some degree afflicted with it. And in that month no less than forty died of it on board the *Centurion*. But though we thought the distemper had arisen to an extraordinary height, and were willing to hope that as we advanced to the Northward its malignity would abate, yet we found, on the contrary, that in the month of May we lost double that number. And as we did not get

to land till the middle of June, the mortality went on increasing so that after the loss of above 200 men, we could not at last muster more than six foremast men in a watch capable of duty. The havoc which this dreadful calamity made in those ships was truly surprising. The *Centurion* from her leaving England, when at this island (Juan Fernandez) had buried 292 men and had but 212 remaining of her complement. The *Gloucester* out of a smaller complement, had buried the same number and had only 82 alive."

Scurvy was likewise common among armies and in besieged towns. At the siege of Thorn in Prussia, in 1703, above 6000 of the garrison, besides many of the inhabitants, died of scurvy. Scurvy was often present among the inhabitants of cold countries like Russia, and even during the winter and early spring in England. The word was in common use, and a poor joke was a "scurvy jest."

Cockburn in 1696 was one of the first to point out the cause and cure for scurvy. For he observed that sailors living upon salt meat and flour developed the disease, but that it was promptly cured by eating green vegetables. But since green vegetables could not be carried on long voyages, this led to nothing. Lind in 1753 published a book emphasizing the dietary cause of scurvy and pointing out the great value of oranges and lemons as a cure, and recommended carrying these juices on long voyages as an antiscorbutic. Blane repeated this recommendation in 1785 and persuaded the naval authorities to give it a trial. Accordingly in 1793, the *Suffolk*, a flagship of 74 guns, made a voyage of nineteen weeks to the East Indies without touching at any port. Each man was given daily $\frac{3}{4}$ ounce of lemon juice with 2 ounces of brown sugar in addition to the customary ration. On the arrival of the *Suffolk* at Madras, there had not been a single case of scurvy. This result, truly remarkable for those days, was so impressive that lemon juice was introduced as a regular item of the naval ration in 1795. One ounce was given daily to each man, and this single measure completely eradicated scurvy from the British navy. Scurvy had always been present in the Navy, sometimes leaving ships helpless. Yet so suddenly was scurvy eliminated, that although in 1780 there were 1457 cases of scurvy admitted to a single naval hospital in England, in 1810 one of the physicians of that hospital stated that he had not

seen a case of scurvy in seven years. The introduction of lemon juice as an antiscorbutic may therefore be estimated as one of the greatest sanitary improvements of all times.

Although as the result of this information, scurvy became very rare in civilized countries, little further was learned concerning the cause of the disease until 1907 when Holst and Froelich discovered that a diet of bread, grain and hay would produce scurvy in guinea pigs. Having found an experimental animal, further progress was rapid. It was found that small amounts of fresh cabbage, carrots or potatoes and of lemon or orange juice would prevent scurvy and would cure it when it had developed. These vegetables lose their antiscorbutic property by long drying or excessive cooking.

There could be no doubt that these fresh vegetables and fruits contain some chemical substance that is necessary to health and even to life. The actual antiscorbutic vitamine has not yet been isolated and identified. As the result of many experiments performed in the effort to identify this vitamine, it has been shown that the great bulk of orange and lemon juice is inert. The majority of the solids of these juices consist of certain sugars and acids. All these can be removed from the juice without affecting its antiscorbutic potency. Recently it has been found that 0.3 gram of material contains all of the antiscorbutic vitamine originally present in a liter of lemon juice. The antiscorbutic vitamine therefore is a very minute fraction of the total solids of such juices; and since one ounce of lemon juice a day is sufficient to protect a man from scurvy, it is evident that extremely minute quantities of this vitamine are sufficient for the maintenance of health. Yet it is so important that prolonged deprivation of this infinitesimal daily dose will result in the development of scurvy.

Although there were over 30,000 cases of scurvy among the soldiers during the Civil War, when dried vegetables were furnished, with the development of cold storage facilities scurvy has disappeared among adults in the United States, since fresh vegetables and fruits that prevent scurvy are accessible at all seasons of the year.

But scurvy still is found occasionally among infants who are

fed on canned or pasteurized milks. Milk contains very little of the antiscorbutic vitamine, at any time. An amount as small as 5 cc. of orange juice or lemon juice daily will protect a guinea pig from scurvy, while it requires about 100 cc. of milk, twenty times as much, to afford the same protection. During the winter when cows get no green food, but are fed hay, the milk may contain none of this vitamine.

Heating quickly destroys the antiscorbutic vitamine except in very acid foods. Therefore pasteurization of milk reduces still further the quantity of vitamine present in the milk or destroys is entirely, so that infants who are fed on canned or pasteurized milk alone are very apt to develop scurvy. The symptoms of scurvy in infants do not appear until after several months of such feeding. All artificially fed infants should therefore be given a few teaspoonsful of orange juice daily. This will entirely prevent the development of infantile scurvy.

The depletion period. It is well known that when an individual receives an infection, a definite period of time elapses before the first symptoms of the disease can be recognized, and this is known as the incubation period. When an individual is placed upon a diet deprived of one of the vitamines, there will also be a considerable period before the first symptoms of the corresponding disease can be recognized. This may be called the depletion period, because experiments have shown that many of the tissues of the body contain a reserve supply of vitamines which must be depleted before the disease can develop. The liver is one of the most important of these depots, containing large quantities of at least three different vitamines. A daily dose of one gram of calves liver is sufficient to prevent a guinea pig from developing scurvy. Ordinary meat contains almost no vitamine. The freedom of Eskimos and other races subsisting entirely upon meat is undoubtedly due to the consumption of the vitamine containing organs, which are often regarded as special delicacies.

The depletion period of scurvy in adults is from four to seven months. We have learned the depletion period in human patients from records of sieges and voyages in which the exact time that the deficient diet was commenced was known, and the earliest case of scurvy noticed was a matter of record.

This period is shorter among susceptible individuals and among those entirely deprived of antiscorbutic foods, and longer among resistant individuals and among those who receive a small but insufficient amount of antiscorbutic vitamine. Experiments on animals have shown that a definite quantity of vitamine is required by each individual. Thus a young guinea pig requires about 5 cc. of orange juice daily to maintain health and growth. If no orange juice at all is given in addition to the scurvy-producing food, such a guinea pig will develop scurvy in from fifteen to twenty days. Should the guinea pig be given half the completely protective dose (2.5 cc.) it will develop scurvy as surely as though it received no vitamines and possibly in a very acute form, but only after a longer depletion period. The first signs of scurvy in such a case may not appear for perhaps two or three months.

Beriberi

Beriberi is a disease characterized by degenerative changes in the nervous system, often combined with generalized oedema (dropsy) and accumulations of fluid in the cavities of the chest and abdomen, and by enlargement of the heart. Sudden death due to heart failure is not uncommon. There are two types of beriberi known as dry and wet. In dry beriberi the symptoms are all caused by degeneration of the nervous structures. In wet beriberi the symptoms are caused chiefly by accumulations of fluid in the tissues. Dry beriberi is undoubtedly caused by the deficiency of a vitamine that may be called the antineuritic vitamine, because the metabolism of nervous tissue cannot be maintained without it, and neuritis develops. Wet beriberi is probably due to some other as yet unidentified food deficiency. However, dry and wet beriberi often coexist.

Beriberi is caused by any diet which is deficient in these vitamines. This deficiency is usually caused by the too exclusive use of decorticated (highly milled) rice,[5] and accordingly the disease

[5] The husked rice grain has three layers: an outer skin called the pericarp, largely composed of mineral salts; within this is a second thicker alerone layer containing almost all the fat, the majority of the protein, and most of the vitamine of the grain. The kernel of the grain is largely starch. In the milling process, the two external layers are usually completely removed, and the grain so produced may be described as "decorticated" or "highly milled."

is usually found among races that use this class of rice as their staple diet. Thus it is common in China, Japan, the Philippines, and certain South American countries like Brazil. It never occurs in the United States except in isolated instances in jails, lunatic asylums, and similar institutions where an improper diet has been used. White bread, hominy, corn meal, and many other carbohydrate staples prepared from decorticated grains are just as deficient in vitamine as is rice, but the people of the United States are protected because none of these foods are used exclusively, but a general mixed diet is consumed. Among many orientals on the other hand, rice forms almost their exclusive food, and it is by no means unusual for them to consume a pound or more of rice daily, with small amounts of fish and vegetables. Rice, therefore, forms the great bulk of their diet, and decorticated rice is quite devoid of the necessary vitamine.

Our knowledge concerning beriberi has been developed from three different kinds of evidence:

1. Epidemiological. It was first suspected that the prevalence of beriberi was related to the consumption of polished rice by observations in prisons. It was found that beriberi was common among prisoners furnished with decorticated (highly milled) rice and rare among prisoners who received rice that had not been completely milled, and which we may call undermilled rice. Prisoners who received rice mixed with barley were protected, whereas their guards eating the same rice without barley developed beriberi.

Later Braddon showed that those natives eating parboiled rice did not develop beriberi. Parboiled rice was cooked and dried before husking so that the husk was easily removed, leaving the entire grain. Those eating parboiled rice were therefore eating whole rice, and were protected.

2. Experimental. This observation led Fraser and Stanton, two observers in the Malay States, to perform a human feeding experiment using 300 Japanese laborers who were employed in a virgin jungle on construction work. They were given a careful physical examination prior to employment, to be sure that they did not have beriberi, and came in contact with no other men after

the experiment commenced. The laborers were divided into two groups. The first group was fed on white or polished rice from which the external layers of the grain had been removed (highly milled). The second was fed whole rice (parboiled rice).

In three months beriberi appeared among the first group eating highly milled rice, but it did not appear among the laborers eating whole rice. The groups were then reversed and group 1 received whole rice, and group 2 highly milled rice; after several months beriberi appeared in group 2 while group 1 was protected. In other words, beriberi always followed the use of decorticated rice and never appeared when whole rice was eaten. This experiment also showed that in adults the depletion period is usually between three and four months, on a very deficient diet. On a partially deficient diet the depletion period may be much longer.

3. Animal experiments. In 1890 Eijkman reported a paralytic disease in chickens similar to beriberi, which he called *Polyneuritis gallinarum.* His attention was directed to this disease by its spontaneous appearance in his laboratory chicken coop. On investigation it developed that the disease only appeared among fowls that had been fed decorticated rice, while those fowls fed on kitchen scraps or whole rice did not develop this form of paralysis. Eijkman also found that fowls were protected when fed on decorticated rice if they were also given the polishings that had been removed from the rice. It appeared practically certain from this observation that there is nothing poisonous or deleterious about decorticated rice, but that something was removed from it in the milling process which was essential to normal nutrition.

Soon numerous investigators were actively engaged in endeavoring to isolate and identify this substance. By elaborate methods of extraction and chemical analysis, several of them succeeded in obtaining a crystalline product from rice polishings which was so active that a dose of a few milligrams would cure birds that were dying of polyneuritis. This is the substance to which the name vitamine was originally applied. Subsequently the term was used to include the whole group of substances similarly essential to health. The amounts of pure vitamine secured, however, were insufficient for careful chemical analysis and the

activity of the vitamine was readily destroyed by heat and alkaline reagents. Because of these difficulties this vitamine has not yet been isolated in pure form at present writing (1927) and we do not know its precise chemical structure. It undoubtedly will be identified eventually for an unknown substance having such important physiological properties is a challenge to chemistry and chemists that will not be ignored.

Meantime it has been found by numerous feeding experiments that many other foods contain this antineuritic vitamine. Beans, peas, barley and yeast are especially rich sources, and yeast has been used extensively as a cheap source for its extraction. This fact has led certain producers of yeast to advocate the eating of yeast for "that tired feeling," and as a generally valuable addition to the diet. This extensive advertising campaign for yeast speaks well for the financial acumen of the advertisers but is not much to their ethical credit. There is not the slightest evidence that people in the United States living on a mixed diet suffer any shortage of this vitamine, and if they did, it could be secured much more easily and palatably in common foods. For this vitamine, although undoubtedly present in yeast, is also found in large quantities in beans, peas, barley, many nuts especially peanuts, and in smaller quantities in many green vegetables. A plate of beans, a dish of peas, or a sufficiency of fresh milk and green vegetables will supply this vitamine quite as well as yeast, as is expressed in the following jingle:

> "Fresh milk and beans have vitamines
> Enough for little Sid;
> So he at least, will need no yeast
> A real self-raising kid."

Bread made from white flour, i.e., from decorticated wheat, is quite as deficient in this vitamine as is decorticated rice, and beriberi may be produced by an exclusive diet of such bread, and by fine cornmeal, hominy, corn starch and other carbohydrate staples. Prisoners cannot be safely fed on white bread alone over long periods and this fact has been recognized in practically all prison regulations. On the other hand, the whole wheat contains this vitamine just as does the whole rice, and it is removed

in the milling process. The use of whole wheat bread is therefore desirable from this point of view, and is to be recommended especially to those that like it. But a properly varied and balanced diet may be relied upon to protect against this deficiency even when white bread is used, as is evidenced by the fact that beriberi is practically unknown in the United States. Eat yeast if you like it; otherwise real food will serve better.

Although the antineuritic vitamine has not yet been identified, we have learned sufficient concerning beriberi, both to prevent and to cure it. Beriberi has been completely eradicated from the Philippine Scouts, a body of Filipino troops. For many years these troops were supplied decorticated rice as the staple of their ration, and at times they had as many as 500 cases of beriberi annually, or 10 per cent of their number (5000). Undermilled rice was substituted in 1910, and within a few months cases of beriberi ceased to appear. Undermilled rice has continued to be used to the present date (1927) and beriberi has never reappeared. All institutions that have made this change have similarly eradicated beriberi. It is therefore a totally unnecessary disease. Chamberlain and Vedder found, in 1911, that infantile beriberi could be cured by the administration of an extract of rice polishings prepared by extraction of the polishings with 90 per cent alcohol, evaporating the alcohol and re-dissolving in water. Adult beriberi may be relieved by the same method, or by the elimination of decorticated rice and substitution in the diet of undermilled rice and other foods rich in this vitamine.

Rickets

This is a very common nutritional disorder of the first two years of life, caused by the deficiency of a fat-soluble vitamine found in milk fat, egg yolk, and in larger amount in cod liver oil. In the absence of this vitamine neither calcium nor phosphorus is retained, although an adequate amount of these substances may be present in the diet. Therefore, calcium or lime salts are not properly deposited in the bones which consequently become soft, cartilaginous and deformed. The majority of cases develop definitely at from six to eight months of age which may therefore be called the usual depletion period.

The earliest symptoms of the disease are apt to be stomach and intestinal disturbances such as vomiting and diarrhoea. The child is pale, restless and irritable, especially at night, and sleep is disturbed by jumping or twitching. A characteristic symptom is sweating of the head which may be profuse so that the pillow becomes wet. Such children do not grow as rapidly as normal infants and teething is delayed. Convulsions may occur. In a series of cases brought for treatment, the reasons for coming to the doctor were as follows: (1) late in teething, 311 cases; (2) bronchial trouble, 269 cases; (3) not walking, 162 cases; (4) sweating of the head, 96 cases; (5) indigestion, 49 cases; (6) convulsions, 47 cases; (7) other nervous symptoms, 34 cases; (8) bowlegs, or other bone changes, 32 cases.

The bone changes commence as soon as other symptoms, but are only noticeable considerably later, when such rickety children are permitted to walk and their legs become bent and bowed. Softening of the bones of the ribs causes such children to become "pigeon-breasted," and softening of the bones of the skull results in a square head with a prominent forehead, a flat top and often flattened sides.

The vitamine deficiency which causes rickets is produced most commonly by artificial feeding with milks or other foods that have been deprived of their vitamine content by heating, drying, or long aging. In a series of cases studied, the mode of feeding was as follows:

	Cases
Artificial foods	476
Condensed milk	254
Dried milk	240
Breast fed	30

On the other hand Dr. Hess of New York finds that many breast fed babies in that climate develop rickets. From this it may be seen that although cases may occur when infants are breast fed, more cases develop when artificial foods are used, and that very few occur on a diet of fresh cow's milk. If artificial foods, condensed milk, and dried milk ceased to be used, rickets would become much less frequent. Unfortunately, some such

mode of feeding is necessary for many infants that cannot be breast fed.

The addition of cod liver oil to such a diet will prevent the development of rickets. Cod liver oil has been used from time immemorial for the treatment of rickets, but although physicians observed the good results of such treatment, the reason for the improvement was not understood until very recently. When it was learned that scurvy and beriberi were caused by a lack of a vitamine, it began to be suspected that rickets also belonged in the group of deficiency diseases. The fact was first proved by Mellanby, who showed in 1921 that puppies fed on an excess of bread, cereals, and other carbohydrates and deprived of meat developed typical rickets, which could be prevented or cured by the addition of certain oils and fats. Of all the fats so tested, cod-liver oil was the best. Later it was found by other observers that rats also develop typical rickets on an improper diet, and since these animals are much more suitable for experimental work, all the later experiments have been performed with rats. Efforts were made to isolate and identify the vitamine present in cod-liver oil. In such experiments the oil was fractionated and the potency of the various fractions was tested by giving them to rats that had developed rickets.

An acid extract of cod-liver oil was made, and in this way from over 2 pounds of cod liver oil about 2 ounces were secured that retained all of the antirachitic vitamine, leaving the bulk of the oil behind. This extract was then made into a soap with caustic potash, just as animal fats may be made into soap by mixing with lye. The alkali unites with the fatty acid leaving glycerin behind. From this saponified portion, about 0.5 gram of a concentrated extract was obtained that contained all of the vitamine. In 1925 Takahashi and other investigators working in the laboratory of Professor Suzuki in the Institute of Physical and Chemical Research at Tokio succeeded in obtaining a very potent concentrate from cod-liver oil and from spinach. They have called this vitamine fraction *biosterin* because it resembles the chemical composition of cholesterin (cholesterol), a well known compound that is present in almost every animal cell, and is particularly

abundant in brain tissue, in the blood and in the skin. A closely related compound known as phytosterol is found in nearly all vegetable cells.

But even while these investigations were being carried out, other observers, while not denying the influence of improper diet in the production of rickets, were pointing out the fact that there were other influences governing the development of this disease. Thus it was found that animals allowed to exercise in the open were much less liable to rickets than animals kept in cages even though they received the same defective diet. It was then learned that light was the important factor. Animals kept in bright sunshine did not develop rickets on the defective diet, but developed rickets when kept in the dark. Soon it was found that the ultra-violet rays were the active antirachitic element of the light. These experimental observations coincide with the observed facts that the children most prone to develop rickets are those of the poor who live in crowded tenements where they can obtain little light, and that the disease develops usually during the comparatively cloudy winter and early spring, and disappears in the early summer. Infants in several large hospitals are now being cured of rickets by daily exposures to ultraviolet light produced in quartz mercury vapor lamps, which conclusively demonstrates the efficiency of this form of light.

Therefore, so far as rickets is concerned, it has been completely proven that the disease may be produced by two agencies, namely, a diet defective in antirachitic vitamine and a deprivation of the ultraviolet rays from the sun. Rickets may also be cured by the administration of the antirachitic vitamine contained in largest quantity in cod liver oil, or by irradiation with ultraviolet light. Both cod-liver oil and ultraviolet light cause large amounts of calcium and phosphorus to be retained in the body.

All experience indicates that the same disease cannot be produced by two totally different causes, and the natural conclusion must be that ultraviolet light is concerned in some manner with either the production or the activation of the antirachitic vitamine. This was strongly indicated by the fact that biosterin emits invisible light rays of sufficient intensity to act upon a

photographic plate. Later it was found that cod liver oil and egg yolk also emit ultraviolet radiation. Several investigators then showed that inert oils and other foods having no antirachitic action, may develop such properties after exposure to ultraviolet light. Cholesterol that was believed to be pure was given antirachitic properties by irradiation. It was next discovered that cholesterol purified by certain processes could be not activated and that a common impurity of cholesterol called ergosterol was destroyed by these same processes of purification. Exposure to ultraviolet light produced in ergosterol a much more potent antirachitic action than had ever been obtained with any other substance. It therefore seems almost certain that ergosterol or some closely related sterol, when activated by ultraviolet light is the anti-rachitic substance present in cod liver oil and other animal fats, and may for convenience be called the antirachitic vitamine.

Experiments have been performed indicating that the living animal forms antirachitic vitamine when exposed to ultraviolet light. Cows of the same age and calving date and receiving the same feed were placed side by side in a dairy barn, and none of the cows left the barn during the experiment. Part of the cows received ultraviolet light for thirty minutes a day from a Cooper Hewitt mercury vapor light held at three feet above their backs. The other cows received no such light. The milk from these cows was then used to treat animals that had developed rickets. It was found that after a month's treatment, the animals receiving milk from radiated cows were cured, while the animals receiving milk from the cows that were not radiated, showed constantly increasing symptoms of rickets. The absorption of ultraviolet light by the cow therefore, leads to the production of the antirachitic vitamine in the milk. Hess has also found that irradiation of nursing mothers with ultraviolet light greatly increases the antirachitic substance in human milk. In animals the specific sterol in the skin probably becomes activated, i.e., given antirachitic properties by the action of light. It is possible that this vitamine can be produced both in animals and plants only through the action of ultraviolet light upon the ergosterol or similar sterols present.

These scientific observations have very practical applications: Rickets may be prevented or cured:

1. By feeding infants preferably by breast milk, or with fresh modified cows' milk.

2. When this is impossible, and infants are fed on canned or dried milks, they should be given a teaspoonful of cod liver oil twice daily.

3. In any case, infants should not be kept all the time in dark rooms, but should be given a daily airing in the light. This does not mean that they must be exposed to direct sunlight, but that they should be outdoors, for the ultraviolet rays are for the most part incapable of passing through glass windows.

By observing these precautions, rickets should become as rare in infants as scurvy is in adults.

Xerophthalmia.

There is still another vitamine present in butter, egg yolk, and certain other animal fats, generally called fat-soluble vitamine. The deprivation of this vitamine results in the development of a condition of the eyes to which the name xerophthalmia is given. The eyes become swollen so that they can only be opened with difficulty or not at all, and the cornea becomes opaque. If the missing vitamine is not supplied, the animals become blind, and soon thereafter die. With protracted deprivation of this fat soluble vitamine, the conspicuous pathological defect is a keratinization of epithelial tissues. That is, there is a widespread tendency for a transformation of normal secreting and other columnar and cuboidal epithelial cells into the heavily hornified type normally serving in the external layer of the skin for protective purposes. This change is general, but is especially pronounced and first noticed in the eye. But the introduction of butter into the diet will cause prompt recovery even in animals that are about to die, and complete recovery occurs in about two weeks, if vision has not already been destroyed.

This condition has been described most frequently in rats that have been fed on experimental diets of various grains. It has also been observed in fowls fed on rice alone, and especially

when fed upon whole rice over long periods. For when fed upon decorticated rice, they succumb to beriberi before the development of xerophthalmia.

A similar human disease has been observed several times, when owing to famines, the diet has been abnormal. Fourteen hundred such cases were described among children in Japan during a period of food shortage and it has also been reported in Copenhagen and certain other parts of Europe under similar circumstances. So far as known, it has never occurred in the United States. The principle sources of supply of this fat-soluble vitamine are butter, egg yolk, and the leaves of plants such as lettuce, spinach, cabbage, etc. The glandular organs of animals such as liver and kidney also contain a rich supply of this vitamine. Vegetable fats such as olive oil, peanut butter, cottonseed oil, and cocoanut oil, do not contain this vitamine. It is also lacking in grains and cereals, many tubers or roots such as radishes, beets, carrots, and turnips, and in ordinary meat.

There is no danger of shortage of fat soluble vitamine when butter, milk, eggs, or green leafy vegetables are freely used in the diet, and this vitamine is mentioned, solely because it is impossible to formulate a correct dietary without a knowledge of its sources.

Pellagra

Pellagra is a disease characterized by gastro-intestinal disturbances, by nervous symptoms including insanity in certain instances, and by a peculiar skin eruption which causes a roughening of the skin. The name pellagra means rough skin. The disease is caused by malnutrition as the result of a deficient diet, but the precise deficiency has not been absolutely defined.

Pellagra is an old disease and was first described by Gaspar Casal in a book written in 1735, but not published until 1762.

Pellagra has occurred in nearly every country in Europe, but it has been very common in the northern part of Italy. In the United States, pellagra is frequent in the Southern states, where it occurs particularly in rural districts and among the population of cotton mill villages. It is also frequently found in insane asylums, orphan asylums, and prisons. Pellagra has always been associated with poverty, and is rarely seen in the well-to-do.

Symptoms. Loss of strength and weight, with nervousness and insomnia are early symptoms. Indigestion with constipation or diarrhoea is common, and may be associated with a sensation of burning in the mouth. These symptoms commonly appear in the late winter or early spring and after a few weeks or months the characteristic eruption appears about May or June. This eruption is a bright red flush like a case of sunburn, which has a peculiar tendency to affect both sides of the body symmetrically. The backs of the hands and wrists, the backs of the feet and the neck and face are common locations for this symptom. As this flush or erythema subsides the skin becomes pigmented and scaly and the skin may become cracked and fissured. This eruption generally disappears by early fall. The mental faculties are often affected and this mental disturbance may progress to real insanity requiring commitment to an asylum. Fortunately this latter is not usual, for not more than two or three per cent of people afflicted with pellagra become insane.

The cause of pellagra. The earlier theories concerning the cause of pellagra originated in Italy where it was observed that the majority of pellagrins lived upon polenta, a food made of corn meal. It was claimed by these Italian observers that pellagra was caused by eating corn, particularly spoiled corn. It was later found that pellagra often developed among people who ate no corn at all. But observations in many places in the United States showed first that pellagra usually occurred among poor people whose diet consisted chiefly of bread, sometimes of wheat, sometimes of corn, with small quantities of salt pork and greens; and secondly, that those families who used milk, eggs, or meat freely did not develop pellagra. This indicated that a deficiency produced by a one-sided diet of cereals caused pellagra, and that pellagra could be either prevented or cured by the addition of milk, meat or eggs. This theory was confirmed by the work of Goldberger of the United States Public Health Service. This observer produced pellagra experimentally among a group of convicts who were fed on such a diet of cereals, and also showed that pellagra could be cured by the free administration of milk, eggs and meat, and that it could be prevented from developing

in institutions that had previously been afflicted by this disease, by the same improvement in the ration. A quite similar conclusion was reached by Wilson in a study of the incidence of pellagra among Turkish prisoners of war and of convicts in Egypt. Wilson concluded that pellagra is the ultimate result of a deficient supply of proper (grade A or animal) protein.

This comes back to the discussion of the proper amount and character of protein required for the daily metabolism. There is no doubt that a diet consisting chiefly of wheat and cornbread supplies a sufficient quantity of protein; but it is quite as certain that faults of nutrition will occur when the protein intake is limited in this way to that obtained from 1 or 2 grains such as wheat or corn. When rats are fed on such diets, they fail to grow and ultimately die. They do not develop pellagra but this may be because this experimental animal cannot develop pellagra. However, dogs so fed develop a disease called "black tongue" which some think is analagous to pellagra.

All animals do not develop all deficiency diseases even though fed on a deficient diet. Thus neither rats nor birds develop scurvy when fed upon the diet that will produce scurvy in the guinea pig, the monkey or man. So the fact that most experimental animals do not develop pellagra on the diets that produce pellagra in man, while unfortunate because we are deprived of a suitable experimental animal in which the disease could be further studied, in no way disproves the fact that a one-sided diet of wheat or corn or both will produce pellagra in man.

It is possible therefore, that pellagra is caused by a deficiency in certain amino acids through the consumption of a diet in which protein is furnished only by a narrow selection of grains or cereals. When this amino acid deficiency is made up by the addition of grade A proteins of animal origin, such as meat, milk, cheese and eggs, the disease may be both prevented and cured.

But many of the diets studied in institutions and families that suffered from pellagra were deficient in some of the vitamines, also, and vitamine deficiency may possibly be responsible for the development of pellagra.

Goldberger believes that yeast and certain vegetables prevent

and cure pellagra in man and black tongue in dogs. From this he concludes that yeast contains some other important dietary factor which he designates as "P.P." (pellagra preventive), in addition to the antineuritic vitamine. Thus, while further investigation will be necessary to identify the precise dietary constituent whose absence causes pellagra, there can be little doubt that pellagra is a true deficiency disease.

Pernicious anaemia

Very recent developments indicate the possibility that pernicious anaemia, a disease of which the cause has hitherto been a complete mystery, may also be a deficiency disease.

Anaemia is a condition in which the number of red blood corpuscles is reduced below normal. It occurs as the result of malaria, hookworm infestation, haemorrhage, and many other infections and abnormal conditions. In such instances blood regeneration is prompt when the cause of the anaemia is removed. Pernicious anaemia is a recurring and fatal form of anaemia for which no cause could be found. It is a fairly common disease usually occurring in middle life, and is twice as common in males.

The disease commences insidiously so that the date at which it commenced cannot be fixed. Indisposition to exertion with a feeling of faintness or breathlessness are the first symptoms. Soon the anaemia and weakness become extreme, and blood counts under 2,000,000 or less are common (normal 5,000,000 red cells per cubic millimeter of blood). There is a lemon yellow tint of the skin, and a characteristic feature of the disease is that there is very little loss of weight. Gastrointestinal disturbances are common, especially diarrhoea, and the stomach no longer contains the hydrochloric acid found always in health. This clinical picture is extremely suggestive, and the diagnosis is confirmed by a blood examination which reveals an extreme anaemia, but with a relatively high percentage of haemoglobin, and the presence of red blood cells of abnormal shapes and structure.

Whipple and Robbins had been studying experimentally produced anaemia in animals for the past ten years, and their work indicated that beef liver hastened the regeneration of the blood.

This was applied to human cases suffering from pernicious anaemia. On August 14, 1926, Minot and Murphy reported in the Journal of the American Medical Association the apparent cure of 45 patients suffering from pernicious anaemia. This remarkable improvement was brought about by the use of an ordinarily good diet to which from 120 to 240 grams of cooked calves or beef liver were added daily. In a later article, (April 16, 1927) Murphy, Monroe and Fitz showed that this diet of liver caused prompt delivery of new young red blood cells into the general circulation.

Calves' livers contains an unusually large amount of all of the well known vitamines, as well as a high percentage of iron and many other complex organic substances. Some experiments have indicated that anaemia may be caused by a deficient supply of vitamine A (fat soluble), and that this is the ingredient in liver that is responsible for the great improvement in pernicious anaemia. This is by no means proven and it may well be that liver owes its action to several of its constituents. But in any case there is good reason for the belief that pernicious anaemia is the result of a long continued defective diet, that it may be greatly improved or cured by the addition of liver, and for these reasons may logically be included in the group of deficiency diseases.

Conclusions

Four different deficiency diseases, scurvy, beriberi, rickets and xerophthalmia are known to be caused by the deprivation of specific vitamines. Pellagra and pernicious anaemia are possibly caused by vitamine deficiency. In addition to these a vitamine called bios has been isolated which promotes the growth of yeast, and the recent work of several investigators suggests the existence of another fat soluble vitamine concerned with reproduction and lactation. Thus if rats are raised on diets consisting of purified food substances, inorganic salts and the already described vitamines, they may fail to breed properly. In both sexes this failure seems to be associated with a variety of disturbances in the sex organs. The vitamine that corrects this deficiency is found in the oil from the wheat germ, a substance that contains none of the other known vitamines.

As these vitamines have become multiplied there has been a tendency to prefer letters to descriptive names in identifying them. According to this classification we have:

A—the vitamine whose deficiency causes xerophthalmia
B—the vitamine whose deficiency causes beriberi
C—the vitamine whose deficiency causes scurvy
D—the vitamine whose deficiency causes rickets
E—Bios—promoting the growth of yeast
F—Reproductive vitamine
G—P.P.—Pellagra preventing vitamine

The first five are relatively well known. Three of them, B, D, and E have been isolated in relatively pure form. The last two (F and G) have not been so completely demonstrated, and further experiments will be required to show whether the undoubted food deficiencies that they represent should be included in the group of vitamines.

Table 17 indicates the distribution of the better known vitamins in natural foods. A rough attempt has been made to give some idea of the relative value of foodstuffs containing these factors by employing more than one positive sign. A negative sign indicates the absence of a factor, whilst an interrogation mark shows either a doubtful result or that no investigation has been made.

At present we do not know the precise physiological action of any of the vitamines. Nor for that matter do we know precisely how insulin acts in the utilization of sugar, nor precisely how the secretion of the thyroid and parathyroid glands exert such a profound effect upon metabolic processes. As we commenced this chapter, so we may end it. We are only on the threshold of a scientific understanding of metabolism. But we know enough about it to prescribe a diet that will produce an equilibrium of metabolism, so that health may be maintained. This is the only part of dietetics that has a practical or sanitary bearing. The scientific problems in nutrition have been pointed out because of their general interest, and as indicating the line of further discoveries in the field of nutrition.

TABLE 17

Distribution of vitamines in natural foodstuffs

A = "fat-soluble A;" B = "water-soluble B" or antiberiberi factor; C = "water-soluble C" or antiscorbutic factor; D = "fat-soluble D" or antirachitic factor.

FOOD	A	B	C	D
Milk	++	+	+	++?
Butter	+++	−	−	+++
Cream	++	+	+?	++
Separated milk	−	+	+	−?
Whey	−	+	+	−
Egg yolk	+++	+	−	+++
Egg white	−	+?	−	−
Beef fat	++	−	−	+
Lard	−	−	−	+?
Vegetable oils	−	−	−	−
Animal fat, margarines	+	−	−	+?
Vegatable oil, margarines	−	−	−	−
Lean meat	−	+	+	−
Liver	++	++	++	++
Heart, kidneys	+	+	+	?
Pancreas	+	+	+	?
Brain	+	+	+	?
"Lean" fish, e.g., cod	−	+	?	?
"Fat" fish, e.g., herring	+	+	?	?
Fish roe	+	++	?	?
Cod-liver oil	+++	−	−	+++
Fish-body oils	++	−	−	?
Wheat, whole grain	+	++	−	−
Wheat, embryo	++	+++	−	−
Wheat, endosperm	−	−	−	−
Wheat, bran	−	+	−	−
Rice, polished	−	−	−	−
Rice, whole grain	+	++	−	−
White bread	−	−	−	−
Wholemeal bread	+	++	−	−
Yeast, dried	+?	+++	−	−?
Yeast, extract (commercial)	−	+++	−	−
Cabbage, fresh	++	+?	+++	−?
Cabbage, dried	++	+?	−	−?
Spinach	++	+?	+++	−?
Potatoes	−	−?	++	−
Oranges	−	−	+++	−
Tomatoes	−?	−?	++	−
Onions	−?	−	++	−
Apples (green)	−?	−	++	−
Lettuce	+	−	+++	−?
Peas, dry	−?	++	−	−
Peas, fresh	+	++	+?	−
Malt extract	−	−	−?	−

REFERENCES

(1) Lusk: The Science of Nutrition. W. B. Saunders Co., 1917.

(2) Talbot: The Caloric Requirements of Normal Infants and Children from Birth to Puberty. *Amer. Journal of Diseases of Children*, **18**: 229, October, 1918.

(3) Lusk: The Fundamental Requirements for Energy for Proper Nutrition. *Journal of the American Medical Association*, **70**: 821, 1918.

(4) Blunt and Dye: Basal Metabolism of Women. *Journal of Biological Chemistry*, **47**: 69, 1921.

(5) Gephart, F. C.: Report of a Dietary Study of St. Paul's School, Concord, N. H. *Boston Medical and Surgical Journal*, **176**: 17, 1917.

(6) Chittenden: Physiological Economy in Nutrition. F. O. Stokes Co., New York, 1904.

(7) Marine, Lenhart, Kimball and Rogoff: The Prevention of Simple Goitre. *Bulletin, Western Reserve University*, November 26, No. 7, July, 1923.

(8) Tice: Practice of Medicine. Vol. IX, articles on Scurvy, Beriberi, Rickets and Pellagra.

(9) Vedder: Beriberi. Wm. Wood & Company, 1913.

(10) Mellanby, Edward: Experimental Rickets. Special Report Series No. 61, Medical Research Council, published by His Majesty's Stationery Office, 1921.

(11) Wilson: The Diet Factor in Pellagra. *Journal of Hygiene*, **20**: 1–59, July, 1921.

(12) Goldberger, Wheeler and Sydenstricker: A Study of the Relation of Diet to Pellagra Incidence. *Public Health Reports*, March 19, 1920, pp. 468–713.

(13) Goldberger, Wheeler, Lillie and Rogers: A Further Study of Butter, Fresh Beef, and Yeast as Pellagra Preventives, with consideration of the Relation of Factor P.P. of Pellagra and Black Tongue of dogs to Vitamine B. *Public Health Reports*, February 19, p. 297, 1926.

CHAPTER IV

Diseases of the Glands of Internal Secretion

Internal secretions, entering the blood, produce profound changes in distant organs or structures and have therefore been called chemical messengers or hormones, and the glands themselves have been named endocrines. One of the most remarkable of these hormones is *secretin*, a substance secreted by the mucous membrane of the upper part of the small intestine, and carried by the blood to the pancreas, stimulating the secretion of the pancreatic juice. The production of secretin is in turn stimulated by the out-pouring of the acid contents of the stomach. As the result of this chemical mechanism, the pancreatic juice is secreted just when it is needed in the process of digestion, and only then. Some writers enumerate about fifteen separate endocrine glands that produce such hormones. At present some of these are hypothetical, but there can be no doubt that the pancreas, thyroid, parathyroids, adrenals, the pituitary and the sex glands produce hormones, and the last three each produce more than one.

The theory has been advanced that racial characteristics, and individual personality are produced by variations in the function of these endocrine glands and that these variations are hereditary. While there is at present no proof that this is true, it must be admitted that the whole disposition and outlook on life as well as the intellectual activity of an individual may undergo radical changes as the result of alterations in the endocrine glands.

The endocrine glands are not independent but their activities are coördinated so that the secretion of each one influences the secretion of the others to some extent. This fact is undoubted, but in spite of elaborate physiological investigations and much speculation, but little is known concerning the exact mechanism by which this coördination of hormone activity is accomplished. Using a figure of speech we may say that the hormones act in coöperation to produce the normal bodily activities as the vari-

ous wheels of a watch interlock to produce the orderly movement of the three hands around the dial. Since all these wheels are closely inter-related, the maladjustment of one wheel will throw the entire mechanism out of balance. So the proper functioning of each of these endocrine glands is dependent upon the normal secretion of the others.

Whatever the mechanism that effects this coördination may be, the normal secretion of each endocrine gland is essential to health, and various diseased conditions are caused by the suppression, the increase or the chemical alteration of these hormones. Here we are upon solid ground, for our knowledge concerning the action of these internal secretions originated through the study

TABLE 18

Rate per 100,000

	1900	1905	1910	1915	1920	1924	1925
Massachusetts	11.8	14.2	17.0	18.2	20.6	19.3	20.0
United States Registration Area	9.7	12.9	14.9	17.5	16.1	16.6	16.9

of the diseases so produced. Some information concerning the physiological action of these hormones, and the diseases produced by alteration in them, is essential to an understanding of the causes of disease.

DIABETES

One of the commonest and most distressing of this group of diseases is diabetes. Since 1900, there has been an upward trend in the death rate from diabetes in the United States (see table 18).

It appears therefore that diabetes is becoming more common, but possibly the increase may be attributed to the improved diagnosis following better and more frequent medical examinations.

Symptoms

The earliest symptoms of diabetes are intense itching called pruritus, an increase in the frequency of urination, and in the

quantity of water passed, together with an abnormal thirst, and increased appetite. The greater consumption of food instead of leading to an increased weight and strength, is followed by decreasing weight and weakness. The resistance of the skin to infection is decreased, so that crops of boils or carbuncles are very common complications. Often this is what brings the patient to the doctor who examines the urine and discovers the diabetes.

The cause

Diabetes is caused by a failure of the internal secretion of the pancreas, a secretion which in some way enables the body to consume carbohydrates. As a result, the body loses its ability to use carbohydrates and there is an accumulation of sugar in the blood. When the amount of sugar in the blood reaches a given point (about 0.18 per cent) it overcomes the barrier imposed by the kidneys and overflows into the urine. This may be first detected by a medical examination for life insurance or by any other medical examination in which the urine is tested. Or the disease may last for some time before detection.

But every person having sugar in the urine has not necessarily diabetes. An over-indulgence in candy or other sweet foods will sometimes so flood the blood with sugar (glucose) that it appears in the urine. This is called *alimentary glycosuria*, and is transient. Some few people have a peculiarity of the kidneys as a result of which sugar passes through them more readily than usual, and such people may have sugar in the urine frequently or even continuously. The condition is called *renal glycosuria*. But renal glycosuria can only be distinguished from diabetes by a chemical examination which determines the amount of sugar in the blood. In renal glycosuria the per cent of blood sugar is not increased, while in true diabetes it is increased.

Diabetes will be better understood if the method by which the body utilizes carbohydrates is described. All carbohydrate foods, including the various starches and sugars, are reduced to glucose in the process of digestion, which is initiated by the ferment *ptyalin* in the saliva. Ptyalin changes starch to sugar very rapidly, but only acts in an alkaline medium. Digestion of

starches therefore only continues in the stomach until its contents are rendered acid by the gastric juice, but is resumed in the small intestine where the contents once more become alkaline in reaction, and the powerful starch-splitting ferment *amylase* is contributed in the pancreatic secretion that is poured into the intestine.

As glucose is formed, it is absorbed and carried to the liver where it is changed into *glycogen*, a substance having the same chemical composition as starch, but differing from vegetable starch in many of its characteristics, so that it has often been called animal starch. One of the functions of the liver is to serve as a storehouse for glycogen, and ten per cent of the weight of the liver may consist of this stored glycogen. Glycogen is also stored in considerable amount in the skeletal muscles. From these storehouses the glycogen is contributed to the blood as it is needed, but before being poured into the blood stream it is changed again into glucose. It is not known precisely how the glucose from the intestine is changed into glycogen in the liver, or how the glycogen in the liver is reconverted into glucose in the blood, but the fact is undoubted. Furthermore there is some mechanism whereby the amount of glucose in the blood is held at a pretty constant level of from 0.06 to 0.12 per cent in health. As the glucose in the blood is oxidized into water and carbon dioxide liberating the energy required for heat and muscular activity, the level in the blood is maintained by fresh additions from the liver. It is believed that the secretion from the adrenal glands regulates the storage of glycogen in the liver, and its mobilization into blood sugar.

The precise method by which this blood sugar is broken into carbon dioxide and water is again not understood and this problem must be solved before we can fully understand the production of diabetes. But this much is known, namely, that the oxidation of the blood sugar is effected by means of the internal secretion of the pancreas. It has been shown that this internal secretion is contributed by certain groups of cells in the pancreas called the *islands of Langerhans*, and it is this secretion which Banting and his collaborators isolated from the pancreas of animals and named

insulin. Insulin is administered by hypodermic injection and thus gains access to the blood where it acts just as it would if it had been poured into the blood as the internal secretion of a normal pancreas. This enables the diabetic to utilize sugar again.

Therefore insulin is not a cure for diabetes as some have supposed, because it does not rejuvenate the diseased pancreas. If the islands of Langerhans have been destroyed by disease, they cannot be restored any more than a man with an amputated leg can grow a new one. But the proper administration of insulin enables the body to use sugar just as an artificial leg enables a man who has lost his leg to walk.

Since the discovery of insulin, a determined effort has been made to identify the active principle of this extract. During 1926, two workers, Dr. John J. Abel and Dr. Casimir Funk both announced that they had succeeded in isolating this active principle in crystalline form. The activity of these crystals is so great that 1 mgm. of the crystals has as great a therapeutic effect as one hundred units of the solution of insulin now used in practice. The preparation of these crystals is now a matter of extreme difficulty, but whenever a chemist can isolate a pure substance in crystalline form, the next step is to analyze it to determine its precise chemical constitution and structure. When this is learned, it is always possible that further study will result in methods whereby the substance can be made synthetically in the laboratory. So it is possible that in a few years the chemists may be preparing pure insulin in the laboratory, and there will be a cheap and unlimited supply of this very useful remedy.

Diabetes is caused by some alteration of the islands of Langerhans in the pancreas, as the result of which insulin can no longer be produced and sugar can no longer be utilized by the body; and when the pancreas of diabetics is studied after death, it is found that these islets of Langerhans have degenerated. But we would like to know what causes the disease and destruction of this important tissue. At present, no conclusive answer can be given to this question. Although diabetes may occur at any age, it is most frequent during the fifth and sixth decades of life. It may well be that in certain instances the degeneration of this important

glandular tissue is one of the first manifestations of the universal degeneration that occurs with advancing years. This is rendered more probable from the fact that diabetes appears with increased frequency in certain families and races. The Jewish race is particularly susceptible to diabetes. It may be therefore that there is a hereditary tendency to diabetes, but this is far from being proven.

On the other hand, beginning diabetes is frequently associated with obesity, and there is a theory that diabetes may be caused by an over-indulgence in food, particularly in carbohydrate foods, which by throwing an undue strain upon the islands of Langerhans, leads to their early degeneration. But although this theory is attractive, in that if true, it would be possible to prevent the disease, there is no sufficient evidence that this theory is true either. But whether true or false, there is sufficient evidence of the general injurious effects of over-eating, to make us avoid this popular indoor sport. Even though diabetes is not directly caused by over-eating, it is certainly aggravated by it, and a mild case of diabetes may thus be made severe.

Prolonged nervous strain may also be an exciting cause. Certain it is that when the diabetic process is once established, nervous strain and exhaustion cause an acute exacerbation of all symptoms including an increase in the amount of blood sugar.

There is the remaining possibility that the degeneration of the islands of Langerhans may result from some infection or from the poisons or toxins generated by infections. It is well known that the toxins of certain infections have a selective affinity for particular organs. Thus the toxins of diphtheria and typhoid fever have special affinity for the heart, the toxin of tetanus for the nervous system and scarlet fever is known to be especially injurious to the kidneys. Some infection may have a similar effect upon the islands of Langerhans. The exact part played by these various factors in the production of diabetes will have to be determined by future study.

Treatment

The treatment of diabetes is dietetic, combined with the use of insulin. Mild cases can be controlled by the elimination of sugar

from the diet and a reduction in the amount of starch. The diet is controlled by frequent tests of the urine and blood. If the urine is kept sugar free, no strain is being placed upon any remaining tissue in the islands of Langerhans, and the disease may remain stationary for many years. If the urine is not kept sugar free, the disease as a rule increases in severity.

One of the methods of determining the carbohydrate tolerance of a patient is to put him to bed at absolute rest and allow no food until the urine is sugar free. Small amounts of starchy foods are then given and increased until sugar once more appears in the urine. By this means, the maximum amount of starch or other foods that the patient can tolerate are determined, and thenceforward the patient must live on this diet. Often considerable weight will be lost on such a diet, but eventually a point will be found at which the weight remains stationary. The diabetic patient, who is unable to utilize the normal amount of food for a person of his natural weight, may be able to utilize the quantity of food required for a lesser weight, and thereafter lives on this lower plane of metabolism and energy expenditure. Long lists of foods are printed which may be used by diabetics, and after a short experience such people soon learn what they can and cannot eat.

In severe cases of diabetes there may be inability to eat any starch or sugar at all without the appearance of sugar in the urine. Such cases formerly died eventually in what was known as diabetic coma, a condition caused by acidosis.

Acidosis

This term deserves a little explanation, because the condition is not confined to diabetes, but occurs, especially in children, as the result of certain infections. The blood is normally alkaline and the excretion of the carbon dioxide produced in the body is dependent on this alkalinity. The sodium carbonate in the blood combines with the carbon dioxide in the tissues forming sodium bicarbonate. This is carried to the lungs where the sodium bicarbonate gives up carbon dioxide which is exhaled, and the sodium carbonate so formed returns to the tissues to

repeat the process. In acidosis, acids are retained in the blood, form fixed salts with the sodium and combination with carbon dioxide is thereby prevented. Any such interference with the excretion of carbon dioxide is serious, and if extensive results in death.

In diabetes, two acids, known as beta-oxybutyric acid and diacetic acid are produced from foods because of the inability of the body to utilize sugar; for when carbohydrate cannot be burned, neither can fats or proteins be properly utilized. This has been expressed figuratively by the statement that fats and proteins are burned in the fire of the carbohydrates.

Fats are composed of glycerin and a fatty acid, and the fatty acid is split off in the digestive process. In normal digestion these fatty acids are oxidized to harmless substances, but in the advanced diabetic who can use no carbohydrate, this oxidization ceases with the production of beta-oxybutyric acid. The same acid may also be formed from protein. The acid so formed unites with the sodium carbonate of the blood to form fixed salts which are excreted in the urine, but the greatest amount of acid that can be normally excreted in this way is about 30 grams. If the production of acid is greater than this amount, it remains in the blood. In any case the amount of alkali in the blood is reduced by this process. It has been found that the alkali balance of the blood can be restored by administering sodium bicarbonate (ordinary baking soda), and this remedy is now used in all cases of acidosis produced by diabetes or from other causes. The excretion of acid in the urine may be increased by this method to as much as 150 grams.

As far as diabetes is concerned, when the disease becomes so accentuated that the amount of carbohydrate that can be used is less than 50 grams a day, acidosis appears, and the excretion of these acids in the urine was formerly regarded as the beginning of the end. Now by the administration of insulin, the ability of the body to use carbohydrates is restored; and with this restoration the ability to utilize fats and proteins is also restored, the abnormal production of acids ceases, and the acidosis disappears.

From this it will be seen that the use of insulin not only adds

to the comfort to the diabetic, but in advanced cases of the disease actually saves life. It is, however, a remedy that must be given in very accurate dosage, depending upon the amount of carbohydrate to be burned. Any excess of insulin causes great prostration, which may be relieved by the administration of a little sugar.

If the proper idea has been conveyed in presenting this outline of the fundamental disturbance of nutrition that causes diabetes, and the principles of treatment of that disease, the reader should have a conception of the complexity of the problem, and of the necessity that each diabetic should consult a specialist for the proper study of his case. Such a study includes chemical analyses of the urine and blood as an indispensable pre-requisite for the prescribing of a proper diet.

DISTURBANCES OF THYROID SECRETION

The extent of the damage produced by an abnormal thyroid secretion is proportional to the extent to which the secretion is altered. Certain diseases caused by disturbance of thyroid secretion are relatively common, and in addition there are a large number of cases in which the alteration is insufficient to produce marked disease but does cause a considerable departure from robust health.

The thyroid gland consists of two lobes, one on each side of the upper part of the trachea or windpipe, connected by a narrow band which passes in front of the trachea. It has no duct or external secretion and in health we are totally unconscious of its presence.

Having found that the administration of thyroid glands from animals cured diseases caused by the absence or deficiency of this secretion (cretinism and myxoedema), chemists made a study of the secretion from thyroids obtained from the slaughter house to determine its chemical composition. Baumann discovered in 1895 that iodine was always to be found in this secretion in relatively considerable amount. It was soon found that the physiologic property of the thyroid secretion depended chiefly upon some organic compound containing iodine.

In 1919 Kendall, a chemist working under the Mayo Foundation, succeeded in isolating the active principle of the thyroid gland, which he named thyroxin. Thyroxin is a colorless, odorless, crystalline substance having an iodine content of 65 per cent. About 0.12 per cent of this substance is now obtained from the fresh thyroid gland, and when administered to patients, produces all the effects of the thyroid gland itself, with the advantage that a more accurate dosage may be given hypodermically if desired.

The reader of this popular manual, if any, will doubtless be intrigued to learn that Kendall originally described thyroxin as 3, 5, 6,—Trihydro—4, 5, 6—tri-iodo, 2 oxy-3 indol-propionic acid. More recently (1926) Harrington and Barger have succeeded in making thyroxin synthetically from certain coal tar products and iodine, and claim that it is a tetraiodo substituted derivative of the p-hydroxyphenyl ether of tyrosin. These terms, which mean nothing to anyone except the organic chemist, are quoted to indicate the great complexity of the substances produced by the body. Such physiologic studies can be conducted only with expert chemical assistance.

The diseases caused by abnormalities of the thyroid may be due to either absent or deficient secretion or to an excessive or altered secretion. The secretion of the thyroid gland acts normally in some unknown manner as a regulator of metabolism, and has been compared to the part played by the governor of an engine. Whenever there is a deficiency of secretion, metabolic processes are sluggish in proportion to the degree of deficiency. The disease produced depends upon whether this deficiency existed at birth or developed at a later period of life. On the other hand when the secretion is excessive, all metabolic processes are greatly hastened. If these simple facts are borne in mind there will be little difficulty in understanding the diseased conditions that result from such changes in thyroid secretion.

Cretinism

Cretinism results when the secretion of the thyroid is deficient at birth, or during the active period of development comprising

infancy and childhood. The infant fails to grow and does not develop mentally. This is so marked that cretins seldom attain a height of 4 feet even as adults, and they are generally idiots. Their appearance is very repulsive. The skin is dry, the hair thin, and the face stupid with open mouth and swollen protruding tongue, from which saliva drips. Cretins usually die young. In other cases where the deficiency is not so marked or occurs later in childhood, there is some further growth and mental development. When the deficiency is least marked, the children merely become backward, grow slowly, and are stupid in school.

If such cases are given thyroid gland or thyroxin, the results are remarkable when the treatment is commenced early. Both body and mind develop rapidly. If the deficiency has existed a long time before treatment is commenced, the results are not so good, and the growth and intelligence never approximate that of the normal child. Fortunately, advanced cretinism is rare, although there are more children who suffer from a slight deficiency. Any backward child should be examined to determine whether this condition exists.

Myxoedema

Myxoedema is a similar disease of adults caused by thyroid deficiency occurring in later life, usually between the sixteenth to sixtieth year. It may be produced by any inflammation or degenerative process that affects the thyroid, destroying its glandular tissue. This gland is not very susceptible to such destructive agencies, so fortunately the disease is rare.

The result of the deficient secretion is a lowered metabolism manifested by a lowered body temperature and an increase in weight accompanied by loss of strength and mental inactivity. There is a peculiar mucoid accumulation in the tissues under the skin from which the name is derived. Since in myxoedema all oxidation is reduced, the temperature of such patients is below normal, the circulation is poor and they feel cold in temperatures agreeable to normal people. They are sluggish, and become easily fatigued, and are dull mentally. The mucoid infiltration is not watery as is the case in the dropsy of cardiac or kidney disease,

but the skin is elastic and does not pit on pressure. This fluid is generally distributed, so that the face becomes swollen, the eyes puffy and partially closed, and the body and limbs are also thickened. The skin is dry and the hair coarse and sparse. This condition may last for years, or may be fatal if untreated. On the other hand the administration of thyroid gland or thyroxin results in immediate improvement and often in return to a normal condition. Administration of thyroid must be continuous thereafter if the improvement is to be maintained; and as an excess of thyroid is also productive of disease and must be avoided, careful dosage is required. Thyroid is administered in small and gradually increasing doses until the body temperature and pulse are raised to normal. Temperature above normal or rapid pulse indicate an excessive dosage. Such patients obviously require constant medical supervision which may secure them many years of active and useful life.

Hypothyroidism

Although pronounced cases of thyroid deficiency resulting in typical myxoedema are rare, there are many people who suffer from a mild deficiency of this secretion. Such cases often remain untreated because their symptoms are not sufficiently acute to attract attention, and are usually vague. They include a loss of circulatory activity, and susceptibility to cold, dryness of the skin and hair, premature ageing and lack of intellectual interest.

In old age the thyroid atrophies, and the graying or falling of the hair, the dry and wrinkled skin, lowered temperature, indigestion and emaciation, characteristic of "the lean and slippered pantaloon" may be attributed partly to the general slowing of metabolism caused by the gradual diminution of thyroid secretion. Hypothyroidism in early adult life hastens these signs of age. Another frequent type of hypothyroidism is the sluggish individual of increased weight. In women this condition is frequently associated with disturbances of menstruation which is sometimes markedly decreased or increased. Other cases complain of backache, which, however, often has a different cause.

This condition also requires thyroid treatment, but the diagnosis of these cases is not easy, and the promiscuous use of thyroid, especially by those whose increased girth is in reality owing to their inability to resist the pleasures of the table, cannot be too severely reprehended. Fortunately there is a good test to gauge the activity of the thyroid, namely the determination of the basal metabolism. In physiologic laboratories, this is done in special calorimeters that measure heat production, oxygen consumed, and carbon dioxide excreted. But for hospital use the determination of the amount of carbon dioxide excreted and oxygen consumed is sufficient.

This test requires a special apparatus and must be given by a specialist trained in its use. But although this test requires skill if the results are to be accurate, it is very easy for the patient, and the principle on which it is based is readily understood. As explained in the previous chapter, metabolic processes are proportional to the absorption of oxygen and the elimination of carbon dioxide from the lungs. The intensity of the metabolic processes can therefore be gauged by the amount of carbon dioxide exhaled. With increased muscular activity the amount of carbon dioxide is greatly increased. The basal metabolism is the minimum occurring when the body is at absolute rest and without food. The normal basal metabolism has been determined for different ages, sexes and weights, and is the basis upon which appropriate diets are prescribed. In all conditions in which the function of the thyroid is diminished, all metabolic processes are decreased, and the basal metabolism is proportionately lower. When the thyroid is increased in activity, the basal metabolism is proportionately higher.

The test is made by requiring the patient to be at absolute rest on a bed for about an hour before breakfast. The patient is then made to breathe for ten minutes through a tube leading to a gasometer or air tank which is so accurately balanced that it requires no effort to breathe into it. The air thus exhaled is collected and the amount measured in this gasometer, and the test is finished so far as the patient is concerned. The air exhaled is then analyzed and the per cent of carbon dioxide determined.

Knowing the total amount of air exhaled, the total amount of oxygen consumed and carbon dioxide excreted for ten minutes while at absolute rest is readily computed, and the basal metabolism is easily calculated, and compared with the normal for the patient's age, sex and weight.

A new method of testing basal metabolism by measuring the loss in body weight caused by the so-called "insensible perspiration" has been suggested recently. Body heat is regulated by the evaporation of perspiration. Insensible perspiration represents the excretion of this moisture plus the loss caused by the excretion of carbon dioxide from the lungs. This loss of body weight if measured at frequent intervals on a delicate balance has been shown to indicate the trend of metabolism as well as the customary laboratory method of measuring heat production in a calorimeter. It is possible that in the future this test may be of considerable value in studying basal metabolism, since patients too ill to be subjected to the usual methods of estimating it can easily stand this test.

The patient's basal metabolic rate is not considered to be abnormal so long as it is not more than 10 per cent under or over the accepted standard for an individual of that age, sex and weight. Beyond these limits, thyroid disease may be suspected. If the basal metabolic rate is 20 per cent under normal, it is highly probable that a condition of hypothyroidism exists. If the basal metabolism is 20 per cent above normal, a condition of hyperthyroidism is equally probable. The basal metabolism of those who owe their fat to over-eating is normal.

The administration of thyroid for hypothyroidism should in all cases be checked by such a determination of the basal metabolism. When so properly administered and controlled, great improvement often results.

Goitre

Goitre is the term applied to enlargement of the thyroid. Plummer, of the Mayo Clinic, as the result of a long study has classified goitres according to their structure, function, cause and symptoms as: (1) diffuse colloid goitre (2) adenomatous

goitre without hyperthyroidism (3) adenomatous goitre with hyperthyroidism, and (4) exophthalmic goitre.

1. Diffuse colloid goitre, often called simple goitre, is caused by an increase of the colloid or gelatinous material occurring normally in the thyroid. This results in an enlargement of the thyroid gland causing a more or less prominent swelling in the front of the neck, without any increased secretion or evidences of hyperthyroidism. It is especially common in children and young adults. A great deal of work has been done on this subject recently. For many years it was known that a large percentage of the people in certain regions developed goitre and it was especially prevalent in mountainous districts, as in Switzerland. So far as the United States is concerned, the territory surrounding the great lakes is a goitre country. For example, Dr. Kimball of the Ohio Health Department made a survey of the school children of Marion, Butler and Washington counties in Ohio, and found that of 20,278 children examined, 26.5 per cent of the boys and 39.2 per cent of the girls had enlarged thyroids. In Michigan 31,612 school children were examined in four representative counties and 40.5 per cent of the boys and 53.8 per cent of the girls were found to have simple goitre.

It was believed for many years that the drinking water bore some relation to the development of simple goitre, but little further progress was made until 1910 when David Marine found that goitre occurred in all the hatcheries where brook trout and other species of the salmonidae were reared. Under the conditions in which these fish lived, an enlargement of the thyroid occurred at about the second month of life, and increased progressively during the period of growth of the fish. A careful study of this abnormality of fish was made. It was first found that fish fed on beef liver always developed goitre, while those fed on whole sea fish escaped. It was then found that these goitres were caused by a deficiency of iodine which was almost absent in liver but present in fish. The administration of iodine to these fish caused the rapid disappearance of the goitres, and prevented the development of goitre in normal young fish.

These results were at once applied to the study of goitre in

man. Iodine is essential to the formation of the secretion and to the proper functioning of the thyroid gland. It was shown by experiments in animals that as soon as the store of iodine in the thyroid falls below 0.1 per cent, enlargement of the gland begins. No enlargement occurred when the amount of iodine in the thyroid was kept above this amount. It was found by extensive chemical examinations of the drinking water in many goiterous and non-goiterous localities that the only essential characteristic of the water in goiterous regions was a deficiency of iodine. Since iodine is present in relatively considerable amounts in sea water and in sea foods, the absence of goitre among those folks living near the sea, and the high percentage of goitre among people obtaining their water and food from inland sources that contain relatively very little iodine, is readily understood.

A test was next made to determine whether the administration of iodine would reduce the prevalence of goitre. Marine and Kimball examined all the schoolgirls from the fifth to the twelfth grades of Akron, Ohio. The boys were not examined because of the relative infrequency of goitre in boys. In April, 1917, at the first examination, 56.4 per cent of the girls had more or less enlargement of the thyroid (goitre). Half of these girls were given three grains of sodium iodide for ten successive days each autumn and spring for three years. The remaining half not receiving the prophylactic constituted a basis for comparison. Of pupils under observation for two or more examinations, 2190 took the treatment and 2305 received no iodine.

Of the 2190 girls taking the iodine treatment, 5 developed enlargement of the thyroid, while of the 2305 not taking the prophylactic 495 developed enlargement of the thyroid.

Of the 1182 girls with thyroid enlargement at the first examination who took the prophylactic, the thyroid decreased in size in 733, while of 1048 pupils with thyroid enlargement at the first examination who did not take the prophylactic, the thyroids decreased in size in only 145.

As the result of this experiment the fact that the administration of iodine will prevent simple goitre has been generally accepted, and various means have been suggested and tried for

the relief of goitre in those districts where it is prevalent. Thus a definite amount of iodine has been added to the drinking water in several cities, and various preparations of iodized cooking salt have been recommended for general use in these districts. But many experienced students of thyroid disease have disagreed with these programs, and have pointed out that they may be dangerous. It is not to be supposed that if a "little will do good, more will do more good." It is known that a certain percentage of simple goitres later develop toxic adenomas with symptoms of hyperthyroidism. Even minute amounts of iodine given to persons suffering from such adenomas, may be sufficient to produce the symptoms of hyperthyroidism.

Iodization of drinking water has been carried out scientifically in Rochester, New York, since April, 1923. Twice a year sufficient sodium iodide is added to the water for twenty-one alternate days to make a concentration of iodine ranging between 14 to 28 parts per billion. From actual analyses of the water it is estimated that each person in Rochester receives 3.1 mgm. of iodine in one year. No instances of hyperthyroidism following the use of this iodized water have been recorded, and it is highly improbable that these small amounts of iodine can do any harm. The health authorities of Rochester claim a reduction in goitre incidence following this use of iodine. (*Public Health Reports*, May 20, 1927.)

On the other hand it has been reported from one clinic in Cleveland that from one quarter to one half of all the cases of hyperthyroidism requiring an operation for the removal of the thyroid during the first six months of 1926, have been either caused or made very much worse by the use of iodized table salt. The conclusion is justified that the use of iodine in drinking water is worthy of further investigation, but that the additional administration of iodine should be a function of physicians rather than grocers.

Iodine may be safely administered to practically all children and it is evident that many children in goitre belts between the ages of ten to twenty years should receive small doses of iodine several times a year for the prevention of simple goitre. Such

administration should be intrusted to school physicians, who could readily make the prevention of goitre a part of their regular duties. Under such medical control, those who need iodine will receive it in proper amounts, and those whom it may injure will be protected.

2. Adenomatous goitre without hyperthyroidism. An adenoma of the thyroid is a benign tumor which is often encapsulated. It causes none of the symptoms characteristic of an increased secretion, but may require surgical treatment because of the pressure produced by the growth which may interfere with breathing or because of the danger that it may become malignant later. The distinction between this type and simple goitre can only be made by an experienced physician. The administration of iodine may aggravate the condition.

3. Adenomatous goitre with hyperthyroidism. This is an adenoma that has developed all the systemic manifestations of oversecretion of thyroxin. Some believe that simple adenomas acquire this type through the improper administration of thyroid gland or iodine. The symptoms are nervousness and mental instability, tremor, a rapid pulse rate, loss of weight and an increased metabolic rate, and the only treatment is surgical removal.

4. Exophthalmic goitre. In addition to the enlargement of the thyroid prominence of the eyeballs also occurs, together with all the symptoms produced by an excessive thyroid secretion. It is now believed that in exophthalmic goitre the secretion of the thyroid is not only increased, but in addition is qualitatively altered and that this accounts for the prominence of the eyeballs (exophthalmos). Typical exophthalmic goitre is relatively uncommon. In a large general hospital in New York during six years of observation, among 8000 ward patients and 181,477 outpatients, there have been less than 200 cases of true exophthalmic goitre. This is one case to every 250 hospital admissions and one to every 5000 dispensary cases. There are many more atypical and early cases of the disease in which some of the classical symptoms are absent.

The greatly increased metabolism produced by excessive excretion of the thyroid manifests itself in increased circulatory activ-

ity, particularly by rapid heart beat or tachycardia. The pulse may rise to 150 per minute, and the throbbing of the heart disturbs the patient even at night. With this there is often an increased temperature of a degree or more. The destruction of tissue results in marked loss of weight and bodily weakness, and tremor which is increased by fatigue. The loss of weight is often excessive, and may reach 100 pounds in several months. Mental activity is also increased and is often accompanied by irritability, emotional outbursts and insomnia. As may be seen these symptoms are almost the reverse of those produced by deficiency of thyroid secretion, and when combined with an obvious enlargement of the thyroid, and prominent eyeballs constitute a symptom complex that is readily diagnosed.

Little is known with regard to the cause of this condition. It has been attributed to the toxemia produced by various infections. It is at least true that the first symptoms of hyperthyroidism often date from some infection. Nervous strains such as severe fright appear to have some influence. Heredity may play a part as exophthalmic goitre appears frequently in certain families. Many more cases occur in women than in men. There is a close relation between the ovarian secretion and the thyroid and the thyroid usually enlarges with pregnancy. Exophthalmic goitre in women is frequently associated with the menopause which in turn is associated with functional changes in the ovarian secretion. It is well known that the functions of the glands of internal secretion are not independent but are closely correlated. This relationship is now being studied by clinicians and physiologists and it is to be hoped that a better insight into this relationship will eventually result in an improvement in the treatment of all of these specific abnormalities including hyperthyroidism.

The medical treatment of such cases is limited but very important, and consists of rest, in severe cases prolonged rest in bed. All mental excitement is to be avoided. By this means metabolism is reduced to the lowest possible point. This is supplemented by a full diet, in which a minimum of meat is recommended, in order to compensate for the increased metabolism and to prevent loss of weight.

As there is an obvious increase in the size of the thyroid, the surgical removal of the majority of the gland is followed by pronounced benefit and often by a cure. Each case requires careful study before operative treatment can be recommended. Strangely enough, the administration of small quantities of iodine prior to operation causes an alleviation of all the symptoms and enables the patient to stand the operation better. This is one of the best reasons for the belief that in exophthalmic goitre the secretion of the thyroid is chemically altered.

Mild cases of hyperthyroidism

For every typical case there are many cases suffering from a mild excess of thyroid secretion. The symptoms in such cases are the same in kind as those already described, but of less degree, and often escape attention. Since some of these cases are progressive and eventually develop into typical cases of exophthalmic goitre, they should receive more medical supervision than they generally do. An excessively rapid pulse, and loss of weight and strength, should be sufficient indication for a medical consultation. These symptoms by no means always indicate hyperthyroidism, but their exact significance can only be determined by a thorough examination. The basal metabolism test is of great assistance in making a diagnosis in doubtful cases.

PARATHYROID DEFICIENCY

The parathyroid glands are four small structures of about the size of a pea lying directly behind the thyroid, often embedded in the capsule of the thyroid. Two of these glands were discovered in 1880, and the other two were not found until 1893 so that our knowledge of their function is quite recent. The secretion of the parathyroids acts in some manner as a regulator of calcium and phosphorus metabolism. When they are removed, as often happened in earlier years with the removal of the thyroid, and as may now be done on experimental animals, the amount of calcium salts present in the blood is greatly reduced and the symptoms of tetany appear.

TETANY

This disease, which rarely occurs at present, was so called because it resembled tetanus. The symptoms develop a few days after the removal of the parathyroids and consist of very painful spasms of the muscles of the extremities, often followed by true convulsions. These attacks may last for hours or even for days. If removal of the parathyroids is not complete, the patient may recover, but when completely removed, the condition persists and usually ends in death. Since the spasms are caused by the lack of calcium in the blood, it was found that the administration of 10 grains of calcium lactate hourly relieved the tetany temporarily; but permanent relief could only be secured by the administration of fresh parathyroid tissue. In 1925 Collip succeeded in preparing an extract from the parathyroid glands of animals which, when given hypodermically to animals suffering from tetany, causes the amount of blood calcium to be restored to the normal level, and relieves all symptoms of tetany. This is an interesting and important scientific advance, and may result in the elucidation of the manner in which calcium metabolism is controlled. It is of less importance than insulin from the medical point of view since surgeons now use the greatest care to spare the parathyroids, and tetany has become exceedingly rare. It may result occasionally from disease of the parathyroids, in which case Collip's extract may be used.

THE ADRENAL GLANDS

Lying close to the upper pole of each kidney is a small gland having no excretory duct. Each gland is composed of two portions, an outer or cortex and an inner called the medulla. The microscopic structure of these two portions is quite different and the physiological evidence indicates that each portion contributes an important regulatory secretion or hormone. The secretion contributed by the medulla was isolated as a crystalline body in 1901, has been analyzed and has even been prepared synthetically and is a standard remedy under the names of adrenalin and epinephrin. The secretion of the cortex has not yet been isolated or

identified. Curiously enough, an active principle derived from a plant and called ephedrin, has a chemical structure very like that of adrenalin, and produces almost the same physiologic action. Ephedrin is an alkaloid very recently isolated from a Chinese plant known as Ma Huang which has been used for centuries in Chinese medicine. Ephedrin has the advantage over adrenalin of being more suitable for administration by mouth; but the drug is at present something of a medical curiosity and is not readily obtainable.

When adrenalin is injected into the circulation it causes increased rapidity of the heart, as well as a contraction of all the small arteries and consequently a pronounced rise of blood pressure. To this extent all physiologists are agreed. But although the action of the adrenals has been made the subject of much experimental study, physiologists differ as to the further action of these important glands. There is considerable evidence indicating that it is the secretion from these glands that controls the formation of glycogen in the liver and the mobilization of the glycogen into the blood stream as blood sugar. Thus the adrenal secretion and insulin work together to maintain the correct level of sugar in the blood. According to this view, when the amount of blood sugar falls below normal, adrenal activity raises it; and when it becomes too high the action of insulin is called into play to consume it. Certainly since sugar is being continually burned in the body, while it is added in the food in very irregular quantities, some such regulatory mechanism is essential in order to maintain the almost constant level of sugar in the blood observed in health.

Other observations indicate that the adrenal hormone acts as a regulator of tissue oxidation or oxygen consumption. Increased adrenal secretion not only increases cardiac activity, but the blood pressure, body temperature and respiration are increased also.

These glands are under automatic control by the sympathetic nervous system but are also more or less under the control of the emotions, and their activity is increased by fright and anger. Everyone has observed the increase in muscular power possessed

by an animal or person who is thoroughly frightened or enraged. If a man who thinks he is completely exhausted is really terrified as by the pursuit of a bear, he will find that he can run and climb faster than his best previous record. As the darky said, under similar circumstances, "if I'd have had one feather in my hand I'd have flew." This increase in power is the natural result of the increased adrenal secretion, which not only mobilizes the blood sugar, upon the oxidation of which all muscular exertion depends, but also assists in its oxidation, and finally increases the circulation and respiration in order that the products of this excess oxidation may be carried off as carbon dioxide from the lungs. Thus an animal that has to run or fight for its life has this natural mechanism to produce the great increase in muscular power required by such emergencies.

Deficient adrenal secretion—Addison's disease

The physician Addison first described this disease in 1855, and this was the first contribution to our knowledge of the function of the adrenal glands. Addison's disease is usually caused by tuberculosis of these glands, but any other disease such as a tumor which destroys the adrenal tissue or interrupts its secretion, can produce the same result. The chief symptoms of Addison's disease are progressive muscular weakness, and greatly lowered blood pressure, which are usually associated with gastro-intestinal disturbance such as nausea, vomiting and diarrhoea. In typical cases there is a remarkable bronzing of the skin. The pigment first appears in the skin as small spots which gradually increase and become confluent until most of the body including the mucous membranes become a bluish black or bronze color. The systolic blood pressure may fall as low as 50 (the normal pressure for a man of 40 would be about 130) and this causes a tendency to faint because of lack of blood supply to the brain. The temperature is generally subnormal. All effort is avoided as a result of muscular weakness. Loss of appetite and indisposition to make even the effort to eat are a final expression of this weakness. These symptoms are the natural result of a deficient adrenal secretion just as excessive muscular effort may be made

possible by an increase of this hormone. The disease usually lasts from one to three years before death, which however may occur suddenly at any time.

Up to the present time treatment has been of little value. Administration of adrenalin gives good temporary results, but has no permanent value as might be expected since it is only one component of the complex secretion of the adrenal gland.

Cases have been greatly improved by daily administration of the whole gland and this is the best treatment at present. Further progress must depend upon the isolation of the active principle of the cortex of this gland. Fortunately typical Addison's disease is quite rare.

A moderate lack of activity of the adrenals is more common as the result of certain infectious diseases, notably diphtheria which appears to have a selective affinity for the adrenals, and as the result of excessive muscular exertion. A number of cases of persistent physical depression with subnormal temperatures and low blood pressures were observed in soldiers who had been subjected to unusual physical exertion during the European War. Such cases generally recover after a sufficient rest. Since routine examinations of blood pressure have become so common, a number of individuals having blood pressures considerably below the normal have been observed. Some of these may suffer from a relative insufficiency of adrenal hormone. In general, these cases require no treatment as the condition is not sufficiently marked to cause alarm. As a matter of fact, with the exception of typical Addison's disease, people do not die as the result of low blood pressure. Moderate exercise is often beneficial to such people resulting in an increased secretion, rise of blood pressure and an enhanced sensation of well being. Those having low blood pressures should insist on a thorough physical examination. If no other defect is found, the best policy is to forget the matter of blood pressure entirely. Should the low blood pressure be due to cardiac or other disease, the appropriate advice may be given and followed.

THE PITUITARY GLAND

The pituitary gland, sometimes called the hypophysis, is a small body weighing only about 10 grains, situated at the base of the brain in a depression in the skull. Small as it is, it consists of two parts, an anterior lobe and a posterior lobe separated from each other by a fibrous band, and of totally different origin, structure and function. The functions of these glands are not completely understood, but it appears to be established that the anterior lobe regulates growth, particularly of the skeleton, and also of the sex glands or gonads. The posterior lobe appears to be concerned in the control of carbohydrate metabolism, and with the regulation of the contraction of involuntary muscles like those of the intestine, of the uterus, and of the blood vessels.

The functions of the pituitary may be disturbed by many different types of disease, such as syphilis, or inflammations of the brain (encephalitis) involving this organ. There may be defective development, or retrogressive changes caused by functional disturbances of other endocrine glands. The commonest disease of the pituitary is a tumor or adenoma which is likely to affect both lobes; but there are many cases in which one lobe appears to be primarily affected. The results produced by alteration in a gland that regulates skeletal growth will naturally depend upon the age at which this occurs, and upon whether the secretion is increased or decreased. Many cases begin with over-secretion but the diseased condition eventually ends in under-secretion. The secretion of one lobe may be increased while the secretion of the other is decreased. As might be expected from such a possible series of combinations, the abnormalities produced by pituitary disturbances are extremely complicated, and no attempt can be made here to explain them all.

Alterations of the anterior lobe

1. Pre-adolescent under-secretion. These cases suffer an arrest of skeletal growth and lack of development of the genital organs, which in turn is followed by the non-appearance of the secondary sexual characteristics. Most dwarfs belong under this classifica-

tion. Other cases in which the deficiency is not so extreme are more nearly normal but are characterized by short stature with short arms and legs, and with late or deficient sexual development. Women remain girlish, menstruation may fail to appear, or appear very late.

2. Post-adolescent under-secretion. In such cases, growth is normal since the deficiency has not occurred until the skeleton has completed development. The symptoms are chiefly those of decreased sexual activity. Women commonly suffer from amenorrhoea (failure to menstruate) and often become mannish. Men lose their male characteristics. Before the bobbed hair craze, such people might have been described as long-haired men and short-haired women.

These conditions can be corrected if diagnosed in time by the administration of preparations of anterior pituitary, which are now on the market. This is particularly to be desired in correcting the lack of development caused by pre-adolescent under-secretion.

3. Pre-adolescent hypersecretion. Too active secretion of this lobe during childhood results in an abnormal development of the skeleton, and if the process continues the individual becomes a giant. Giants are not only freaks, but they are usually of low intelligence and most of them die young, often before they are thirty. Frequently the early hypersecretion becomes a later deficiency so that the sexual organs never reach normal adult proportions. There is at present no satisfactory method of treatment for this condition.

4. Post-adolescent hypersecretion. After an individual has attained his full growth and the epiphyses of the bones have ossified, over-secretion can no longer produce gigantism, but it still causes an increased size of certain bones. This is the condition known as acromegaly. Acromegaly usually occurs between the ages of twenty and forty. The shape of the head changes. It elongates, often to a very great degree, the nose becomes thick and widened, and the jaws increase in size. Often the lower jaw protrudes. The bones of the hands and feet increase in thickness, giving the hands a spade-like appearance. Associated with this

are mental changes such as irritability, inability to concentrate, and often headache and disturbances of vision. These latter symptoms are caused by pressure of a tumor of the pituitary upon neighboring structures of the brain. The diagnosis of this condition may be assisted by x-ray examination of the skull, and of the hands and feet. When it can be shown by such examination that there is a tumor of the pituitary, and when obvious pressure symptoms exist, particularly if the vision is threatened, operation may be performed. The technique of this operation has been developed to a high degree of perfection by Dr. Harvey Cushing of the Peter Bent Brigham Hospital in Boston. Dr. Cushing has made a specialty of brain surgery for many years and has succeeded in relieving many otherwise helpless cases.

Alterations of the posterior lobe

A failure of secretion of this lobe interferes in some manner with carbohydrate metabolism resulting in a marked tendency to become fat (Pituitary Obesity).

1. Pre-adolescent. In the growing child there is a diffuse accumulation of fat over the entire body. In many cases the anterior lobe appears to be likewise affected so that the genitalia fail to develop. These cases are called dystrophy adiposogenitalis. (Such names seem very complicated, but the doctor always prefers a name which is descriptive of the condition thus avoiding much circumlocution.)

2. Post-adolescent cases. The same enormous obesity develops, sometimes with secondary atrophy of the genital organs. The fat women exhibited in the circuses are often cases of pituitary hyposecretion. In other men or women suffering from posterior hypo-pituitarism, the excess of fat is limited to a large extent to the hips, the lower portion of the abdomen and the upper thighs. The chest, arms and lower legs may be relatively small. This is known as girdle obesity.

The disease known as *adiposis dolorosa* is probably also caused by an alteration in the secretion of the posterior lobe. This disease is usually found in women of middle age and is characterized by the gradual development of local deposits of fat in various

portions of the body, accompanied by pain of a neuralgic character, and often by muscular weakness.

Many of these cases can be improved by the administration of posterior pituitary extract. In cases where obesity is associated with genital infantilism, both posterior and anterior glands are probably indicated. These conditions need careful examination to determine the type of deficiency; and the administration of pituitary, if necessary, should be carefully controlled by periodic examinations. More harm than good may be produced by the promiscuous use of these potent preparations.

3. Hyperactivity of the posterior lobe. This may be manifested by increased metabolism, polyuria and glycosuria.

Diabetes insipidus

Diabetes insipidus is probably caused by posterior pituitary hypersecretion. In this comparatively rare disease, the flow of urine is greatly increased and may be 6000 cc. or more daily, but no sugar is excreted. Thirst and appetite are increased as in true diabetes. Headaches, visual disturbance and other symptoms caused by alteration of the function of the pituitary may occur.

Glycosuria

Pituitary glycosuria, also rare, closely simulates true diabetes of pancreatic origin. It differs from diabetes in the fact that there is generally a marked increase of carbohydrate tolerance. That is, considerable amounts of starch or sugar must be eaten before sugar will appear in the urine. If, in addition this condition is associated with other pituitary disturbances, as it often is, the diagnosis is readily made. Pituitary glycosuria like true diabetes may be controlled by administration of insulin.

THE SEX GLANDS OR GONADS

Both the male and female sex glands (testicle and ovary) in addition to being reproductive organs of the individual, furnish important internal secretions or hormones. The effect of these hormones is especially noticeable at three periods of life. During

embryonic development these hormones influence the formation and growth of the other genital organs. There is a period early in embryonic development when the sex of the foetus cannot be determined by an external examination. The genital organs of the male and the female subsequently develop from the same embryonic structures, the course of development being governed by the hormone from the gonad whose sex has long been predetermined.

The effect of these hormones is again apparent at the time of puberty when they are responsible for the development of the secondary sexual characteristics. The characteristic body shape appears, the male with broad shoulders and narrow hips, and the female with narrow shoulders and broad pelvis and hips. In the male there is a marked increase in the size of the external genitalia, the appearance of hair on the face and the change of voice. In the female at this period the breasts develop and menstruation begins. That these changes are actually governed by the hormone from the gonad is shown by many facts. When these sex glands are removed before puberty by operation as has been done in many countries in the production of eunuchs, these secondary sexual characteristics fail to develop. The action of these hormones has also been extensively studied in experimental animals, by transplanting the gonads. The testicles and ovaries have been removed, and the testicles reimplanted in the female and the ovary in the male. In such experiments the female assumes many of the male secondary sex characteristics and the male assumes the appearance of a female.

Finally in later life a definite aging occurs associated with a decrease or alteration of these hormones. The falling and greying of the hair, the wrinkled skin, loss of weight and strength, and other signs of age are believed to be partly dependent upon changes in the sex hormones. The menopause or cessation of menstruation is almost certainly conditioned by a deficiency in ovarian hormone. The menopause appears abruptly when the ovaries are removed; and after it occurs menstruation may often be re-established for at least a time by the administration of ovarian extracts. This treatment also gives great relief from the

hot flushes and other circulatory and nervous symptoms of the menopause.

It is of importance to determine what portion of the gonads is responsible for the production of these hormones. In the case of the testicle this is readily determined. The testicle consists of tubules lined with germinal epithelium which produce spermatozoa, and certain interstitial cells. It has been found that in cases where the germinal epithelium was completely degenerated, the hormone was still active and produced a perfect male type. It is therefore the interstitial cells that produce the hormone.

Testicular transplantations have been attempted for the purpose of rejuvenating the aged. Such operations have received much newspaper notoriety although the chaste columns of these periodicals refuse to use such a coarse term as testicle, but use instead the euphonious substitute of "interstitial gland," or "monkey glands." Of these attempts it is sufficient to say that although the principle is probably sound, the technical difficulties are great, and no marked success has been derived from them. It is possible that in future an extract may be prepared which may have a satisfactory therapeutic effect in the treatment of the aged, but no such success has as yet been attained.

The ovary is still more complex, for experimental evidence indicates that in this organ there are a number of different kinds of cells producing various secretions. It is possible that a hormone is secreted from the majority of the tissue or stroma of the ovary. In addition to this when an ovum is produced, it is surrounded by a follicle or cyst containing a small quantity of fluid. It appears that this follicle produces a definite hormone. After the discharge of the ovum, if conception occurs, this follicle is replaced by a definite structure known as the corpus luteum. It is believed that the hormone produced by the corpus luteum is responsible for the cessation of menstruation that occurs during pregnancy, and often for some time after its termination. Allen and Doisey have prepared an extract of the ovarian follicles, which, when injected into the guinea pig, causes a definite acceleration of ovulation; while ovulation is just as definitely delayed by the injection of an extract of corpus luteum. Thus there may be

two and possibly three hormones produced by the ovary, none of which have as yet been precisely isolated and identified. On the other hand there is other evidence indicating that only one hormone is produced by the ovary, and that it is immaterial whether it is isolated from the follicular fluid, the corpus luteum or the whole ovary. Extracts of the entire ovary have been prepared that appear to represent at least a part of the activity of the normal ovarian secretion, and which give relief in cases of premature menopause caused by removal or destruction of the ovaries. But much further work in identifying and measuring the potency of these extracts is required before gonad therapy can be placed on a basis comparable with the present treatment of diabetes with insulin, or of myxoedema with thyroxin. Possible hormones produced by other organs are too vague and hypothetical to even discuss in a work of this nature.

CHAPTER V

The Degenerative Diseases

There has been a considerable prolongation of life resulting from the conquest of the major pestilences and the great reduction in the number of many other infections. But there is no elixir of life, and as deaths from infections are decreased, and the average span of life increases, the number of those living to die from degenerative diseases is necessarily increased.

The principal causes of death for the year 1924 in the registration area comprising 88.4 per cent of the estimated population of the United States, were as shown in table 19. The principal causes of death for 1925 in the registration area comprising 89.4 per cent of the estimated population were as shown in table 20. Thus of the 6 major causes of death, 4 may be classed as degenerative diseases, and the rates for the 2 infectious diseases (pneumonia and tuberculosis) are decreasing, while most of the rates for the degenerative diseases are increasing.

It must be emphasized that all the rates discussed here are crude death rates, which means that they have not been corrected for changes in the population for age and sex. Corrected rates would probably show that the increased number of deaths from degenerative diseases is at least largely due to the fact that with each decade more people are living to the age when these diseases appear.

But this does not alter the fact that at the present time more people are dying of degenerative diseases than ever before.

Since people must die, this is a reasonably satisfactory state of affairs. But it is not ideal because many people die from these degenerative diseases at a comparatively early age, and a great further prolongation of life becomes possible if we can slow up these degenerative processes so that the great majority only die at a ripe old age. Nor does this mean that the world would become filled with doddering incompetents, for if these degenera-

tive diseases were controlled, people would retain the full possession of their mental and physical faculties many years longer. It is desirable to consider these degenerative diseases in order to determine their causation and the means of avoiding them as far as possible.

TABLE 19

*Principal causes of death for the year 1924 in United States registration area**

CAUSES OF DEATH	NUMBERS OF DEATHS	RATE PER 100,000
Heart diseases	176,691	178.4
Pneumonia (all forms)	97,403	98.4
Cerebral haemorrhage and softening	91,941	92.8
Cancer and other malignant tumors	91,138	92.0
Tuberculosis (all forms)	89,724	90.6
Nephritis	88,863	89.7

* *United States Public Health Reports*, January 1, 1926, xl, 12.

TABLE 20

*Principal causes of death for the year 1925 in United States registration area**

CAUSES OF DEATH	NUMBER OF DEATHS	RATE PER 100,000
Heart diseases	191,226	185.5
Nephritis	99,320	96 3
Pneumonia (all forms)	96,432	93.5
Cancer and other malignant tumors	95,504	92.6
Tuberculosis (all forms)	89,268	86.6
Cerebral haemorrhage and softening	87,064	84.4

* *United States Public Health Reports*, January 7, 1927, xlii, 1.

HEART DISEASE

Heart diseases not only constitute the most important single cause of death at present, but the crude death rates have been rising rapidly in recent years. The rates per 100,000 in the Registration area of the United States are as follows:

Year	1890	1900	1910	1915	1920	1921
Rate	121.8	132.1	158.8	165.7	159.3	157.1
Year	1922	1923	1924	1925	1926	1927
Rate	165.7	175.3	178.4	185.5	199.1	195.7

Under the age of twenty-five, heart disease causes more deaths than typhoid. From twenty-five to thirty-four it causes more deaths than pneumonia, yet nine-tenths of the deaths from heart disease are after the age of forty. Dr. Haven Emerson estimated that two million people in the United States suffer in some degree from heart disease. (*Hygiea*, February, 1926.)

A considerable number of these deaths are preventable. Prevention of death from heart disease consists primarily in the prevention of diseases of the heart and secondarily upon annual physical examinations in the course of which any disease of the heart may be detected in its incipiency, and measures taken to correct it, to delay its development and to prevent heart failure. Prevention of diseases of the heart and their early recognition both depend largely upon an intelligent coöperation of individuals with their physician, and such coöperation can only be fully secured when there is a general understanding of the causes of heart disease and its nature.

The heart is a hollow muscle divided by two muscular walls. One such wall or septum is vertical and divides the heart into two halves, right and left; the second septum is horizontal and divides both right and left sides into two chambers, the upper called auricles and the lower ventricles. Between each auricle and ventricle are valves that, when acting normally, prevent any return flow of blood; and the great blood vessels (the pulmonary artery and the aorta) leaving the ventricles are similarly provided with valves to prevent back flow to the heart.

The venous blood from the entire body is collected into two great veins, the superior and inferior vena cava. These empty into the right auricle. The blood entering the right auricle is driven through the tricuspid valve into the right ventricle. This valve closes as the right ventricle contracts and the blood is driven into the pulmonary artery to the lungs. As soon as the ventricle is empty the pulmonary valve closes. The blood returns from the lungs through the pulmonary vein to the left auricle, which, contracting forces it through the mitral valve into the left ventricle. The mitral valve closes and the left ventricle contracts forcing the blood through the aorta into the systemic

circulation. The aortic valve then closes. During this cycle, the two auricles beat together, and a second later, the two ventricles beat together. While life lasts, the heart goes on throwing $3\frac{1}{3}$ ounces of blood seventy or eighty times a minute into the aorta against approximately nine feet of water pressure. The only rest the heart gets is during sleep, when the force and frequency of the beats is somewhat diminished. The frequency of contraction is under control of the nervous system, but the contraction itself is a characteristic inherent in the heart muscle. When suspended in an isotonic fluid (one having the same osmotic tension as the blood), the hearts of some of the lower animals will continue to beat for several hours after complete separation from the body. This intrinsic contractility of the heart muscle is a cause for perpetual wonder.

From this simple description, it will be seen that disease of the heart may originate from any condition that affects (1) the competency of the heart muscle, (2) the competency of any one of these four valves. If any one of these valves fail to act properly, a considerable amount of blood will leak past it at each beat and the heart muscle may be overtaxed in its effort to maintain the circulation. But if the heart muscle is strong enough to perform this extra work, the circulation will be maintained in spite of the leak. Some people have moderate valvular leaks for many years without being aware of this condition, simply because the heart muscle is competent to maintain the circulation. On the other hand if the heart muscle is diseased, or if for any other reason it becomes fatigued and is unable to perform its work, the circulation fails and we have the symptoms of an embarrassed heart. Heart failure is simply inability of the heart muscle to maintain the circulation.

Therefore although valvular disease is serious in that it may and often does lead to failure of the heart muscle, disease of the heart muscle itself is a much more dangerous condition.

In addition to these diseases involving structural change (organic disease) we have disturbances caused by some alteration in the nervous control of the heart which are often called functional. Functional diseases may be serious, but usually may be

controlled and they seldom cause death. The high death rate from heart disease is almost exclusively caused by organic diseases.

The causes of organic heart disease are relatively well known. We should consider first the causes of organic disease of the heart muscle, which may be grouped under four categories: (1) disease of the coronary artery, (2) infections, (3) fatty degeneration, and (4) pericarditis.

Disease of the coronary artery

The heart muscle like other muscles and tissues of the body is nourished by blood, which is supplied to the heart by the coronary artery and its branches. Any disease that affects the coronary artery so as to diminish the amount of blood that flows through it, results in degeneration of the heart muscle. The most important disease of the coronary artery is arteriosclerosis (hardening of the arteries) which results in a thickening of the vessel walls and a diminution in the size of its lumen. If this process is gradual and not very extensive it only interferes with the nutrition of the muscle so that the heart may be capable of performing its ordinary work, but loses its reserve power and the individual is incapacitated for hard work, or any sudden exertion. When the artery becomes markedly narrowed the muscle degenerates and is replaced by fibrous tissue, producing the condition known as fibrous myocarditis. This fibrous tissue is weak, has no contractile power, and a heart so degenerated eventually dilates or ruptures. But when the lumen of the vessel is seriously occluded, or should any branch of the coronary artery be shut off the results are more serious. Sudden occlusion of the coronary artery by a clot of blood, which may form in the diseased artery (thrombosis), or be carried from a thrombus or clot in some other part of the body (embolus), usually results in sudden death. Sclerosis of the coronary artery is usually a part of general arteriosclerosis, a subject that is discussed later.

Infections

The toxic products of all infections are deleterious to the heart muscle, but some of them are especially liable to produce organic

changes. Syphilis is preëminently such an infection, and not only causes a diffuse myocarditis (inflammation of the heart muscle) but also may result less often in the formation of gummas in the heart muscle. These caseous or gummy products of tertiary infection are sharply circumscribed, yellow nodules, that may be half an inch in diameter, and interfere with the heart action so seriously that they often cause sudden death. Syphilitic infection of the heart muscle is one of the commonest causes of myocarditis.

Acute rheumatism (inflammatory rheumatism) also has a marked tendency to produce myocarditis. The organism causing acute rheumatic fever is not known with certainty. There is reason to believe that it is a specific variety of streptococcus that has a special affinity for the joints and heart. The mortality of this painful illness is only about 2 to 3 per cent, but practically all of these deaths are caused by acute myocarditis. This inflammation of the heart muscle probably occurs to a greater or less extent in every case of acute rheumatism, and many who recover are left with badly damaged hearts. Rheumatism affects young adults and children chiefly, so that this form of damage to the heart occurs in early life.

The methods by which the organism of rheumatism gains entrance to the body are not known completely. It is known, however, that the disease frequently follows acute tonsillitis and sometimes other focal infections such as abscessed teeth, erysipelas, and other local inflammations. The prevention of rheumatism and its resultant damage to the heart is therefore chiefly a question of the proper treatment of such focal infections. All children should have their teeth kept in proper condition, and should be examined by a dentist every six months. Acute tonsillitis should never be neglected, but should receive immediate medical treatment, and the tonsils should be removed in all cases in which children or young adults are especially susceptible to such acute infections, or when a chronic infection occurs. Greater attention to these points in recent years has resulted in a considerable decrease in the number of cases of acute rheumatism. The death rate in the United States Registration area per 100,000

for rheumatic fever was 9.5 in 1900, and 3.0 in 1923, and the vital statistics of the United States Army show that the admission rate for rheumatic diseases has decreased from 36.56 per 1000 between 1887–1897 to 13.57 during the five years 1921–1925.

Typhoid fever, diphtheria and scarlet fever are other infections that all result in specific degenerations of the heart muscle. Cardiac degeneration has long been known both as an immediate complication and as a sequel of these diseases. A recent study was made of 16 cases of diphtheria by means of the electro-cardiograph. At the time of discharge from hospital, none of these patients had normal hearts. Nine of the 16 had a pulse rate over 100. The heart beat was irregular in 6 cases, and in 3 there was definite enlargement. The cardiac complications of diphtheria are more universal and more lasting than is generally recognized.

The mortality rates for typhoid fever, acute rheumatic fever, diphtheria and scarlet fever have been steadily diminishing during the past forty years. The incidence of typhoid fever has also undoubtedly decreased, but until quite recent years there has been little reduction in the number of cases of rheumatic fever, diphtheria and scarlet fever, and improvement in their death rates has been accomplished by better treatment of these diseases. More of these cases formerly died.

But few recover from either of these diseases without more or less injury to the heart. It follows that many more people are living today than formerly, who suffered from these diseases in childhood and recovered with permanently damaged hearts. Since those who are dying of heart disease today, suffered from these infections from twenty to forty years ago, the increasing mortality rate for heart disease may well be due to the increasing survival of such weakened persons.

On the other hand, during the past five or ten years there has been an undoubted decrease in the number of cases of rheumatic fever, diphtheria and scarlet fever, and recent developments indicate a still greater reduction. The results of this lessened incidence of infectious diseases injurious to the heart are not yet apparent, but it is to be hoped that in the years to come, such reductions will be evidenced by a decreased mortality rate for heart disease.

FATTY DEGENERATION

Fatty degeneration of the heart muscle properly speaking is of rare occurrence. It is caused by phosphorus poisoning, pernicious anaemia, and possibly by some infections. But fatty infiltration of the heart is relatively common as a part of general obesity. In this condition the heart is surrounded by a sheet of fat, and in certain cases the fat penetrates the walls of the heart, and separates the muscular fibers. The action of the muscle is actually weakened so that the heart is incapable of performing its usual work. This weakened muscle may dilate. Everyone has seen fat people who puff and blow after comparatively slight exertion like climbing a flight of stairs. The prevention of this condition depends upon the prevention of obesity.

Pericarditis

The heart is surrounded by a serous membrane known as the pericardium. The pericardium is a closed sac, surrounding the heart muscle as a small balloon would surround a fist pushed into it. One wall of the pericardium is closely adherent to the outside of the heart and the sac secretes a small amount of serous fluid that serves as a lubricant, so that as the heart beats there is no friction between the two pericardial walls.

Inflammation of the pericardium is called pericarditis, and is the result of infection. The commonest causes of this infection are rheumatism, the various pus producing organisms, the pneumococcus and the tubercle bacillus and syphilis. Rheumatism often results in infections of all parts of the heart, the pericardium, the heart muscle and the valves. Of 330 cases of rheumatic fever at Johns Hopkins Hospital, pericarditis occurred in 6 per cent (Osler). Pericarditis is a frequent complication of pneumonia. Infection with pus organisms often follows tonsillitis and other local infections.

As a result of this inflammation, there is an increase in the amount of fluid in the pericardial sac which may later become purulent. There is pain over the region of the heart, fever, and embarrassment of the heart leads to shortness of breath (dysp-

noea). Dyspnoea is always one of the earliest signs of failing heart action because of inability to deliver blood to the lungs fast enough. In many cases the infection is overcome by the defensive mechanism of the body, the excess fluid is absorbed, and little permanent damage results. But in a certain proportion of cases the inflammation is severe enough to destroy the epithelial lining of the pericardium leaving a raw surface, and the exudate becomes transformed into fibrous scar tissue uniting the two walls of the pericardium to the heart muscle, which enlarges (hypertrophies) and sooner or later dilates.

Dilatation of the heart

The heart muscle may be weakened by any of the degenerations or infections already mentioned. As the blood is returned to the heart at the normal rate, the weakened organ cannot pump it all out, and the increased amount of blood in the heart produces an increased intracardiac hydrostatic pressure. The combination of increased pressure and weak muscle, results in an expansion of size in one or more of the chambers of the heart or dilatation. Dilatation may be sudden as the result of the suddenly increased blood flow caused by some unusual muscular exertion, or gradual. If the dilatation is considerable, it stretches the valves apart, so that valvular leaks add to the embarrassment of the already weakened and stretched muscular fibres. Such acute dilatation or heart strain may occur when a man in poor condition runs after a train, attempts to climb a mountain or undertakes any athletic exercise suddenly when his heart as the result of previous disease, or lack of exercise, is unable to meet the effort. The symptoms are pain about the heart, great shortness of breath and fluttering of the heart with an irregular thready pulse. These symptoms may all disappear after a sufficient rest, but recur after slight effort. The heart has been permanently damaged.

Such damage to the heart may be avoided by keeping the heart muscle in good condition. In addition to avoiding the infections and excess fat, this depends upon taking reasonable daily exercise. Such exercise increases the reserve force of the heart, and enables

it to meet sudden emergencies. Individuals who have been sedentary for many years should never undertake sudden severe exercise.

If the heart muscle is normal, the increased work thrown upon the heart by valvular leaks results in an increased size and power of the heart muscle (hypertrophy) to perform the added task, just as the muscles of a blacksmith's arm increase in size. This hypertrophy is called compensatory because it is by this means that a normal circulation is maintained. But as soon as the leak becomes too serious to be overcome in this manner, or if for any reason the muscle of the heart wall becomes diseased or otherwise weakened, the heart becomes distended or dilated. Valvular leaks are therefore important chiefly as they produce disturbances in the heart muscle.

The causes of valvular disease

Defects in the heart may be congenital. If the defects are serious, the infant does not live. Less serious defects may incapacitate the child permanently for hard muscular effort but do not necessarily interfere with a long and useful life. The commonest defect of this kind is an imperfect closure of the septum between the two ventricles, so that venous and arterial blood becomes mixed in the heart. This results in imperfect aeration of the blood, and a blue color or cyanosis. Such babies are often called "blue babies." A narrowing of the orifices of the pulmonary artery and of the aorta are also fairly common. Such children must be carefully protected from cold, and unusual efforts, and should be under a physician's watchful care. These cases are fortunately relatively rare. Dr. Maud Abbott who wrote a monograph on this subject was able to collect only 412 cases from the large hospitals of Great Britain.

The common cause of valvular disease is endocarditis, or inflammation of the internal lining membrane of the heart (endocardium). The valves of the heart are formed from reduplications of this lining membrane and become involved in any inflammation affecting it. Rheumatism is the infection most frequently responsible for this inflammation of the heart valves,

and about one-third of all cases of acute rheumatism result in some degree of endocarditis. Of 76 hearts coming to post mortem with old valvular defects, the injury was caused in 55 by rheumatic endocarditis. The mitral valve between the left auricle and ventricle is most commonly affected by rheumatic infection. Syphilis is the next most frequent cause of valvular lesions, and the damage caused by this infection is nearly always limited to the aortic valves. Other infections like pneumonia, influenza and gonorrhoea are responsible for a small percentage of cases. The inflammation so produced may result in the production of scar tissue, which, like all scar tissue, later contracts. This contraction may cause a narrowing of the valvular orifices (stenosis) which obstructs the passage of blood through them, or may cause the flaps of the valves to contract so that they do not meet fully, and a leak occurs, and blood regurgitates past the incompetent valve. The character of the valvular disease depends upon the valve affected and which of these effects is produced, so that doctors recognize the following valvular lesions.

Tricuspid	stenosis regurgitation
Mitral	stenosis regurgitation
Pulmonary	stenosis regurgitation
Aortic	stenosis regurgitation

As the blood is forced through the narrowed orifice, or regurgitates through the incompetent valve, it produces an abnormal sound known as a murmur. Each of these cardiac lesions is recognized by characteristic murmurs that may be heard with a stethoscope; by changes in the pulse and blood pressure, and by other physical signs. The hypertrophy that results from such valvular lesions is detected by percussing the heart, and so determining its outline which is larger than normal.

So far as the layman is concerned, diagnosis of these different

forms of heart disease is impossible and all that is necessary is to recognize the first signs of cardiac disease in order that he may consult a physician at the earliest possible time for diagnosis and appropriate treatment that will prolong health and life. The first symptoms of a failing heart are always caused by muscular weakness of that organ, however, the original lesion was produced.

The normal heart possesses the power of maintaining an efficient circulation at all times, and this power, inherent in the heart muscle, is composed of two parts a "rest force" and the "reserve force." The functional efficiency of the heart depends upon the amount of the reserve force, and heart failure invariably begins by a diminution or loss of this reserve force which is shown by inability of the heart to perform any unusual effort.

The chief symptoms of exhaustion of the reserve force include breathlessness, oppression of the chest and the consciousness of violent action of the heart. These symptoms are produced in all people by violent exercise. It is the too ready production of them after relatively slight effort that indicates weakening of the heart. The normal heart soon quiets down after severe exercise. When the reserve force is weakened, a much longer period of rest is required before the heart returns to its normal rhythm. These are the earliest signs of impairment of the heart and should lead to a careful investigation of that organ. If the proper measures are taken at this time, the condition may often be remedied, or at least may be prevented from becoming worse.

The rest force is the minimal force which the heart can exert to maintain the circulation at rest. Impairment of this rest force results in symptoms when the body is at rest. The symptoms of impairment of the rest force are breathlessness while at rest, cough sometimes with spitting of blood because of pulmonary congestion, dropsy owing to weakness of the systemic circulation, and diminution of urinary secretion because of lowered blood pressure and diminished flow of blood through the kidneys. There may be palpitation and cardiac distress. Indigestion is common because of failure of the circulation to the stomach and liver. The blood is not emptied from the veins fast enough.

This causes congestion of many important organs, particularly the lungs, liver and kidneys.

Pain is not a necessary symptom of organic heart disease, and the most advanced lesions may occur without the knowledge of the patient. Pain over the region of the heart is quite as apt to be caused by one of the functional disturbances of the heart, and sharp stabbing pain in the chest is usually caused by intercostal neuralgia. Nevertheless organic disease of the heart sometimes causes pain, one variety of which is most intense and agonizing.

Angina pectoris

Angina pectoris is the name given to these paroxysmal attacks of pain suffered in certain cases of heart disease. The precise cause of angina pectoris is unknown but this symptom is often associated with changes in the coronary artery or in the aorta. The attacks may be precipitated by exercise, or more often by emotions such as anger. When severe, the patient is suddenly seized by an agonizing pain in the chest radiating down the left arm. There is a sense of constriction as though the chest was held in a vise. With this there is difficult and painful breathing and a sense of impending death. The patient's face is pale, and he is unable to move. This pain may last only a few seconds or for several minutes, and may recur at intervals. Death often occurs in one of these attacks.

The prevention of heart disease

The Heart Committee of the New York Tuberculosis and Health Association, investigated 1000 cases of heart disease in adults attending cardiac clinics. It was found that in about three-fourths of the cases, rheumatic fever either alone or in combination with other infections was the cause of the heart disease. Tonsillitis was associated with the rheumatism in about one-fourth of the cases. Rheumatic fever was equally common in males and females. Syphilis was the next most frequent cause. Aortic insufficiency occurred in 15 per cent, aortic stenosis in 3 per cent and aortitis (inflammation of the aorta) in 17 per cent. Syphilis is the most frequent cause of aortic lesions. In syphilitic

heart disease the ratio of males to females was 7 or 8 to 1. Arteriosclerosis, the next most frequent cause, is also often caused by infections, and was also much more common among males than females.

From this it is apparent that infection directly or indirectly plays the principal rôle in the production of heart disease. Mechanical defect in the heart itself, is usually caused by these infections, and strain alone rarely results in injury to a normal heart. The most important measures in the prevention of heart disease consist in the prevention or proper treatment of cases of rheumatic fever, syphilis and other infections.

The prevention and treatment of these diseases has already been discussed, but it must be emphasized that two-thirds of our adult cardiac morbidity is the result of infections, chiefly rheumatic, occurring between five and fifteen years of age. Other infections of childhood are also important causes of heart disease. The effects of diphtheria have been mentioned. The whole group of streptococci appear to have an especial tendency to become localized in the heart and any attempt to control rheumatism must therefore be centered upon the prevention of tonsillitis and other focal infections. Rheumatic fever is in all probability a streptococcus infection derived from some local inflammation, such as tonsillitis. It now seems that both scarlet fever and measles are caused by specific varieties of streptococci. Children should be protected from all of these infections so far as possible, and effort in this direction is hopeful, as will be shown in the following chapter.

After rheumatic (streptococcus) infection has occurred, a further attempt to prevent the development of heart disease may be made by proper medical attention and nursing during the acute, the convalescent and the quiescent stages of the disease. After apparent recovery from acute rheumatic fever every child should remain for several years under medical supervision either of the family physician, or at special heart clinics which are being organized in the larger cities. In these clinics a frequent examination is made to determine the cardiac condition, and proper measures recommended in order to minimize the injury to the heart.

In addition to this effort to prevent and control infection received in early years, all adults, even though apparently well, should insist upon an annual physical examination. This will afford an opportunity for the detection of various types of heart disease, as well as other serious defects, much earlier than has been possible in the past, and at a time when proper treatment and care may remedy the cardiac condition, or at least greatly prolong life.

Functional disturbances of the heart

These are conditions that occur in the absence of any organic disease, but which often cause more disturbance and alarm than do the actual structural changes. This is because the chief symptoms of such functional disturbance are palpitation and pain, which are always noticed.

Palpitation. The normal individual is quite as unconscious of the action of the heart as of other involuntary actions of various organs. In palpitation, the patient is conscious of the thumping of the heart. In cases in which the the heart action is regular and the pulse and blood pressure normal, this consciousness of the heart is caused by an abnormal sensitiveness of the nervous system and is accordingly more often found in women. There is a great difference in the sensitivity of different individuals. A race horse is nervous and excitable under conditions that are unnoticed by a Percheron draught horse. The lower races of men are very phlegmatic, do not feel pain as acutely as the more highly civilized, and suffer very little from shock. Shock is a circulatory failure occurring after severe injuries. The skin is cold and clammy, the pulse weak and fluttering and the patient is profoundly prostrated or even faints. A civilized man who receives a gunshot wound in the chest or abdomen will usually fall to the ground in profound shock even though no vital organ is injured. On the other hand, in numerous instances, uncivilized people and some civilized but phlegmatic individuals have fought for hours after receiving such a wound. Women almost always have a higher nervous sensibility then men. Neurasthenia, which means exhaustion of the nervous energy, hysteria, and

debilitating diseases are especially apt to increase this nervous sensibility and accordingly become the causes of palpitation of the heart.

In other cases the heart acts irregularly. Certain irregularities are indications of organic disease when they may or may not be noticed by the patient, but other irregularities occur in the absence of organic disease. In such instances the heart may beat very rapidly for a few seconds and then return to its normal rate. In other cases the heart appears to stand still for a second or two, and this is followed by a very perceptible and forcible beat. These irregularities, inequalities and intermissions of the heart beat should always lead to a careful examination of the heart to determine the possibility of organic disease. In the absence of organic disease, a very common cause is the excessive use of tobacco, the so-called "tobacco heart." Coffee and alcohol may also be causes. In such cases the nervous mechanism controlling the heart has been poisoned, and it is only necessary to avoid these poisons.

A perfectly regular but unusually rapid heart is called Tachycardia, and may be quite persistent. This may also be caused by tobacco, but is more often due to other causes. It is frequently seen in women at the time of menopause, and is one of the symptoms of excessive thyroid secretion, a possibility that should always be investigated in such cases. Paroxysmal tachycardia is characterized by recurring attacks of rapid heart action, during which the heart may beat from 140 to 190 times per minute. The attacks come on, and end suddenly, and the pulse is normal in the intervals. This condition is frequently caused by indigestion and may be relieved by emptying the stomach. In some cases the cause cannot be found. During such an attack the patient should be placed at absolute rest. Certain drugs afford some relief.

Pain often follows disease of the heart muscle, pericarditis, and aortitis, and cardiac pain should always indicate a careful examination. Nevertheless pain is also common in the functional disturbances caused by poisons, and especially by tobacco, and in gastric indigestion particularly when the stomach is distended

with gas. Cardiac pain in such cases may be alarming, but disappears promptly when the stomach is emptied. Cardiac pain also occurs in women, particularly at the time of menopause, when no other specific causes can be assigned for it.

Arteriosclerosis

Arteriosclerosis (hardening of the arteries) is one of the most important degenerative processes that occur with advancing years. If at all extensive its results are very serious and lead to early death.

Physiology. The blood does its physiological work in the capillaries, and the heart, arteries and veins are only the mechanical means for keeping the capillaries full and renewing the blood in them. The blood is pumped into the aorta intermittently, while the flow in the capillaries is continuous, and the conversion of the intermittent to the continuous flow is accomplished by the arteries. The large arteries leaving the heart, the pulmonary and aorta, and especially the latter are very elastic. They dilate when blood is forced into them from the heart, and as soon as the back pressure has closed the valves and return flow to the heart is impossible, this elastic force causes them to contract and thus assist in forcing the blood into the smaller arteries.

The smaller arteries in turn are not mere passive tubes, but are provided with muscular walls under the control of the sympathetic (autonomic) nervous system. The contraction of these involuntary muscles helps to force the blood to the capillaries in a continuous stream, and in addition the whole artery may expand or contract thus directing the flow of blood to those parts where it is most needed. During digestion, the arteries to the stomach expand and carry more blood to that organ, and exercise causes the arteries supplying the muscles to expand. From the smallest arteries (arterioles) the blood flows into the capillaries which are found everywhere in the body except the hair and the nails, and the blood returns to the heart from the veins into which the capillaries empty.

Blood pressure. Since the continuous passage of the blood through this extensive capillary network and back to the heart

depends upon the exertion of a steady force derived from the heart and arterial contraction, a certain pressure is exerted at all times upon the vessel walls. So far as the larger arteries are concerned, this blood pressure varies at each beat of the heart, being increased to a maximum at the moment the blood is forced into the aorta, and slowly decreasing until the next contraction of the heart. The highest blood pressure is called the systolic, because it occurs during the contraction or systole of the heart. The lowest blood pressure is the diastolic because it occurs during the relaxation or diastole of the heart. The difference between these two pressures is called the pulse pressure, which represents the force rhythmically dispatched by the heart and blood vessels to keep the blood in motion. These pressures vary in different arteries, but it is usually taken in the main artery of the arm (brachial), and it is measured by the number of millimeters of mercury that can be supported in a tube of a given diameter.

What are we to regard as a normal blood pressure? It varies so much in different people and in the same people at different times, that a standard blood pressure for given ages to which all should conform is impossible. Nevertheless as the result of many thousands of observations in health and in disease, evidence on a large scale is available as to what usually constitutes normal pressures in healthy persons. Normal systolic pressure varies between 110 and 150 mm. and readings of 110–125 are most common. Young people have a pressure nearer the lower limit and old people nearer the higher. In exceptional cases the systolic pressure may be as low as 100–105 in subjects in good training, or may be as high as 130–140 in young persons in good health. Therefore although exceptionally high pressures are infrequent in health, and usually indicate disease, it is foolish to attach importance to slight variations from the average. A systolic pressure of at least 90 is necessary to maintain the circulation in the coronary artery supplying the heart.

The diastolic pressure in healthy young adults is usually between 60 and 80 mm., and the pulse pressure is ordinarily 40 to 45 mm. The pulse pressure which indicates the efficiency of the circulation is the most important single measure of blood

pressure. A pulse pressure below 25 or exceeding 60 almost always indicates some circulatory disease.

With advancing years, the arteries become harder and less elastic and the systolic pressure increases. It was formerly taught that after thirty years of age, this average increase is about one millimeter for each year of age, but this rule is only approximate. A child of ten may have a pressure of 110, a young man of twenty, one of 120, or a man of forty one of 140; but a man of seventy should not have a systolic pressure of 170. Gulland has suggested a rule that is possibly closer to the truth, namely, systolic pressure equals 120 plus half the age. Thus:

Age 20 = 130	Age 50 = 145
Age 30 = 135	Age 60 = 150
Age 40 = 140	Age 70 = 155

At all ages persons of heavy build usually average about 10 mm. higher systolic pressures than persons of light build.

If the heart is normal, low systolic pressures after the age of 50 indicate that the arteries are retaining their elasticity longer than usual, and other things being equal point toward a long life. Equally, unusually high systolic pressure for a given age indicates that the arteries are degenerating more rapidly than normal. Since a man is said to be as old as his arteries, the prolongation of life depends to a great extent upon the maintenance of normal arteries, and the acute interest taken in blood pressure is readily understood. Insurance statistics show unquestionably that people with abnormally high pressures are worse risks than those whose pressure is normal. Figures from one insurance company show the ratio of actual deaths to expected deaths, the figure 100 being taken as the normal expectation:

Under 140	102.8
141–170	133.6
Over 170	219.6
200 or over	827.3

Pathology. Arteries are complicated and delicate structures having three well defined layers: the inner composed of a layer of pavement epithelial cells lying upon a membrane containing a

varying amount of elastic tissue, a middle muscular layer, and an outer fibrous layer or sheath. As the result of the action of various injurious agents, the inner coats of the arteries become inflamed, and the dead cells are replaced by fibrous or scar tissue. This process results in thickening of the wall, loss of elasticity and narrowing of the lumen. This process may be general or may affect chiefly certain special arteries, and the results of arteriosclerosis depend upon the arteries affected and the intensity of the process.

Blood vessels are also subject to the same degenerative processes that affect other organs. Fatty degeneration, and processes known as amyloid, hyaline and granular degeneration are common. The tissue destroyed in such degenerated areas is replaced by fibrous tissue, and often lime salts are deposited in small granules which coalesce and may form calcareous plates, or if the process is general the whole vessel may become ossified and converted into a hard and rigid tube, the so-called pipe stem arteries. Arteriosclerosis may end in the narrowing or even obliteration of the vessels in which case the circulation to the parts supplied fails; or when the vessel walls are weakened it may result in their dilatation. The local dilatation of an artery is termed an aneurism. An aneurism commonly continues to expand until it ruptures.

The cause of arteriosclerosis. There are definite structural changes that constitute the basis for senility. The bent posture is caused by an altered position and fusion of the elements of the vertebral column. The wrinkled visage is caused by atrophy of subcutaneous tissues, and the shuffling feeble gait is due to failing motor coördination. There are also changes in the individual cells of all organs with a diminution of the vital protoplasm. Therefore the gradual death of cells and their replacement by fibrous tissue is the more or less inevitable concomitant of age. But the rapidity with which this process occurs varies greatly in different individuals, and it is by no means unusual to find individuals of forty in whom the process has advanced as far as is observed in others at the age of seventy. This is premature senility, and is often hereditary. In certain families the degenera-

tive processes set in early and in others they are late, and it is chiefly this characteristic that results in longevity being an inherited characteristic. The long-lived man has inherited what Osler called "good vital rubber" in his arteries. Age and heredity are beyond our control, but there are many other causes of arteriosclerosis that can be prevented.

1. Infections. Syphilis and tuberculosis are common causes of arterial inflammation and degeneration. Syphilis tends especially to affect the aorta, and aortitis, degeneration and calcification, (atheroma) and aneurism of the aorta are almost always of syphilitic origin. These aneurisms cause great pain and disability and in the end usually rupture causing sudden death. Pus organisms may attack the blood vessels. Probably all infections are injurious to the vascular system since all such organisms produce some toxic substances that circulate in the blood and act continuously on the vessel walls.

2. Intoxications. Other poisons act in the same manner, particularly alcohol. Alcohol is absorbed and circulates in the blood. Alcohol is not a violent poison in ordinary amounts, and accordingly an occasional indulgence is not as injurious to the blood vessels as the constant presence of the irritant. It is the habitual drinker who suffers most from this poisonous action. Lead is especially injurious to the blood vessels. Painters and other workers in lead should use special precautions to avoid absorption of this poisonous metal. Tobacco has been accused of causing arteriosclerosis and so have tea and coffee. The use of tobacco increases the rapidity of the heart perhaps 10 beats a minute, and may raise the systolic blood pressure from 5 to 10 mm. Anything that raises blood pressure may theoretically cause arteriosclerosis. Smoking is so common however, and the damage produced by it in the blood vessels is so vague, that it probably is not a serious cause of sclerosis. The same may be said about tea and coffee. Even alcohol, which is admittedly the more serious poison, produces little damage in those who use it abstemiously. There is not the slightest evidence that Frenchmen and Italians who use wine habitually and temperately suffer more from arteriosclerosis, or die younger than other races.

3. Overeating and obesity is undoubtedly a serious factor in the production of arteriosclerosis, as is continued hard physical labor. These factors have been discussed elsewhere.

4. Finally both kidney and heart disease cause arteriosclerosis. When the heart is hypertrophied, blood pressure becomes higher, and high blood pressure however caused results in an undue strain upon the arterial wall, which in time is deleterious. As the result of kidney disease, toxic products that should be eliminated remain in the circulating blood. On the other hand arteriosclerosis produces both heart and kidney disease. When the arteries are inelastic, the work of the heart is increased and products that should be excreted in the urine pass with difficulty through the abnormal vessels. We have here a vicious cycle, and whether arteriosclerosis is the original lesion or secondary, the eventual condition is cardio-vascular-renal disease.

5. Essential hypertension. This is high blood pressure for which no cause can be found either in the arteries themselves or in the heart or kidneys, or in the ductless glands particularly the thyroid and adrenals that regulate blood pressure. It is usually detected in the course of a physical examination in which the blood pressure is taken, and may be as high as 200 mm. systolic pressure. Since nothing happens without a cause, it is extremely probable that such high blood pressure is caused by disease of some of these organs which we are unable to detect by our present methods of examination. As medicine becomes more exact such terms as idiopathic and essential become more rarely used. However caused, such high blood pressure usually ends in the production of arteriosclerosis and the vicious cycle of arterio-cardio-renal disease.

The effects of arteriosclerosis. Arterial disease may cause death directly or indirectly. The deaths attributed directly to arteriosclerosis in the registration area of the United States are classified under the heading: Diseases of the arteries, atheroma, aneurism, etc. and were responsible for a rate of 23.5 per 100,000 in 1924, 22.4 in 1925, 22.5 in 1926, and 21.8 in 1927. This rate is small as compared with the deaths from heart disease, but is nevertheless the eighth most important cause of death from disease.

The influence of arteriosclerosis upon the production of heart and kidney disease has been discussed. Even more serious is the effect upon the brain, which atrophies as a result of the impaired circulation and defective nutrition. These anatomical changes in the brain are the physical basis for the mental deterioration that is a frequent concomitant of age. The intellectual processes fail, the memory becomes impaired, and the individual enters his "second childhood." Untidy personal habits are common, and often such senile people cannot come to the table but must be fed and cared for like infants. In other cases the affected person becomes irritable, selfish, and may undergo a complete change of character. Such mental changes which have been considered as a normal incident of age are really the result of arteriosclerosis. Those who have normal arteries retain their faculties to the end.

Sclerosis of certain arteries to the brain is one of the causes and perhaps the basic cause of a nervous disease called paralysis agitans. In this condition the patient's face loses its expression and becomes mask-like, a tremor develops which is intensified by any effort such as raising a glass of water or a spoonful of soup, and in walking the patient leans forward and appears to be trying to move the legs fast enough to keep up with the falling body. Sufferers from paralysis agitans will fall if not supported, and often require assistance in the performance of the simplest acts.

The arteries supplying the various portions of the brain are for the most part what is called terminal arteries; that is, they have no communicating branches. When the arteries have degenerated, and especially when the degeneration is the result of syphilis, such an artery may be closed by a clot (thrombosis), and the portion of the brain supplied by that artery, thereafter receives no more blood and the nerve cells and fibres die. This dead tissue disintegrates, becomes more or less liquefied and is gradually absorbed, the process being known as softening of the brain. This causes partial or complete paralysis of various parts of the body or impairment of the intellect or both, depending upon which vessel is affected and the extent of the degeneration. Such changes are generally permanent since nerve tissue cannot

be replaced, although there may be some slight improvement later, probably through education of remaining portions of the brain.

Apoplexy. This is caused by the rupture of a weakened vessel supplying the brain, usually of one of the branches of the middle cerebral artery. Blood is poured out into the brain causing compression and sudden loss of consciousness. The patient cannot be aroused, the face is flushed, the pupils usually dilated and the breathing is slow, deep and loud with expansion of the cheeks or sputtering of the lips. Death may occur at once, but usually after a variable period, consciousness is slowly regained and it is then found that the patient has lost the power of speech, and one side of the body is paralyzed. This is caused by the pressure of the blood upon the speech center of the brain and upon the bundle of nerves passing from the cortical cells of the brain to the body. Since the motor nerves all cross at a lower level of the brain and the sensory nerves cross in the spinal cord, an arterial rupture on the left side of the brain produces paralysis on the right side and vice versa.

As the blood becomes absorbed, improvement occurs, the degree of improvement depending upon the intensity of pressure and the extent of the destruction of nerve fibers so caused. In the course of several weeks, speech gradually returns, and sometimes power returns to the limbs so that recovery is almost complete. More often some incapacity remains. Speech may remain difficult and the patient drags the leg in walking. Power is recovered first in the leg and later in the arm. In many cases some degree of paralysis is permanent, especially of the arm. In such cases the limb becomes rigid and may be contracted.

Cerebral haemorrhage and softening of the brain formed the third cause of death in 1924. It has always been one of the most important causes of death as shown by the following figures giving the rate for these conditions in the Registration Area per 100,000:

Year:	1900	1910	1915	1920	1921	1922	1923	1924	1925	1926	1927
Rate:	75.5	79.5	85.3	86.4	85.1	86.0	90.4	92.8	84.4	86.4	84.0

Since arteriosclerosis causes such profound changes in vital organs like the heart, brain and kidneys, it would naturally be supposed that it affects the rest of the body, and this is indeed the case when arteriosclerosis is general. When the circulation to the legs is insufficient, the nutrition of various parts is disturbed and this may result in the development of leg ulcers, or when the main artery is affected, in gangrene or death and putrefaction of the entire part. This necessitates amputation. In other cases the hardened and narrowed arteries supply sufficient blood while at rest, but insufficient to supply the muscles during exercise. This causes pain and limping when attempting to walk, a condition known to the medical profession as "intermittent claudication."

The prevention of arteriosclerosis. Heredity and age, two very important factors in the development of arteriosclerosis, are beyond our control. But much has been done toward prevention of those infections and intoxications that affect the arteries. The majority of the deaths from apoplexy and softening of the brain that occur prior to the age of fifty are directly caused by syphilis and in many of the deaths at later years, syphilis is a contributory cause. When it is realized that syphilis is the most important of the various infections causing these serious and fatal degenerative diseases, more general interest in the prevention and in the early and thorough treatment of this disease may be expected.

The other factors in the production of arteriosclerosis, such as overeating and obesity, overwork and worry, and excessive indulgence of all kinds are matters of personal hygiene that may be more or less readily regulated.

The importance of periodic physical examination, by means of which the early changes in the heart and vascular system may be detected cannot be overestimated. Much may be accomplished by proper treatment of such early lesions. The prevention of death from the degenerative diseases and the prolongation of life depends largely upon the thoroughness with which such examinations are performed at proper intervals, and the willingness of the patient to follow the regime prescribed for the correction of defects so found.

KIDNEY DISEASE

Nephritis is often called Bright's disease after the great English physician who made the first accurate study of it. The term nephritis literally means inflammation of the kidneys, but only inflammations that do not produce pus are included under the term nephritis. Inflammations that result in the production of pus are included under the term pyelonephritis or pyelitis. Nephritis is further classified as acute and chronic. While acute nephritis is inflammatory in nature, it causes few deaths. The mortality from nephritis is nearly always due to chronic nephritis, which results largely from degenerative processes.

Nephritis has always been one of the most important causes of death. Thus although the statistics indicate that there is no steady increase in the number of deaths from nephritis, this disease was still the fifth cause of death in 1924 and the second in 1925. The crude rates per 100,000 for nephritis (acute and chronic) in the Registration Area are as follows:

Year:	1900	1910	1915	1920	1921	1922	1923	1924	1925	1926	1927
Rate:	89.0	99.0	105.1	89.4	85.4	88.5	90.1	89.7	96.3	98.3	92.5

The kidneys are vital organs. Although total removal or destruction of the kidneys does not cause immediate death as does destruction of the heart or brain, yet death always occurs in the course of several days. The function of the kidneys is the removal of toxic substances from the blood, and life cannot be sustained if these toxic substances are allowed to accumulate. The most important of these substances quantitatively is urea. Urea is the ash that is formed when protein is burned or oxidized in the body, and 1 gram of protein yields about one-third of a gram of urea. Approximately 2 per cent of the urine is urea, and since the amount of urine secreted by adults in twenty-four hours varies from 1500 to 1700 cc. (a little more than a quart and a half), it is apparent that from 30 to 34 grams of urea are excreted daily. Other equally important nitrogenous waste products like uric acid, hippuric acid, creatinin and xanthin are eliminated in smaller quantities. All excess of inorganic salts like sodium chloride, (salt) calcium, various phosphates and sulphates as

well as numerous other substances are likewise eliminated in the urine. Nor is even the elimination of water a negligible factor since the percentage composition of the blood must be held constant, and all water ingested that is not eliminated through the lungs or the skin, must pass through the kidneys. One may well wonder in what manner the kidneys perform this work.

Each kidney is a compound tubular gland; that is, is composed of an enormous number of tubules united by a small amount of connective or interstitial tissue. Each of these tubules commences with a structure called a glomerulus, which is the point of union between the blood vessels of the kidney and the tubules. It consists of a tiny artery which breaks up into a sperical tuft of capillaries and ending in a small vein leaving the tuft where the artery enters. Closely surrounding this tuft is a double walled capsule formed from the tubule. The end of the uriniferous tubule here expands into a balloon-like structure composed of a single layer of the thinnest kind of epithelial cells, and the capillary tuft is pushed into this capsule of Bowman as it is called, so that one layer of cells is closely adherent to the capillary tuft, while the other layer is reflected from its base forming a small cavity. Such a structure forms a most efficient filter for the fluid portions of the blood. The tubule which commences in this way, is further composed of various kinds of glandular epithelium. Its first portion is excessively convoluted; it later forms a long parallel loop, and finally ends in one of the pyramids of the kidney, papillae on the interior of that organ emptying into the ureter, the excretory duct of the kidneys leading to the bladder. It has been estimated that each kidney contains several million of these microscopic tubules each of which functions independently and secretes its own small quantity of urine.

Many efforts have been made by physiologists to determine the precise function of the various portions of these uriniferous tubules. The process by which urine is secreted is not yet fully explained, but the evidence indicates that the glomerulus acts simply as a mechanical filter. Protein cannot pass through such a vital membrane so long as it is unimpaired. The protein free filtrate from the glomerulus contains all crystalline substances

present in the blood serum, particularly urea, uric acid, sugar, amino-acids and chlorides. As this filtrate passes through the tubules, all of the sugar and amino-acids are reabsorbed by the cells lining the tubule and returned to the circulation, together with much of the water and some of the chlorides. Therefore, the function of the cells of the tubules is probably the reabsorption of useful products that pass through the glomerulus by simple filtration. They may also have some power of secreting substances into the urine, but this has not been demonstrated.

In the two kidneys we possess far more glomeruli and uriniferous tubules than are required. In fact one kidney may be removed without apparent injury so long as the second kidney is functioning normally. This is a factor of safety, just as an engineer builds a bridge that will hold a much greater load than anything that can be placed on it. Thus inflammatory or degenerative changes must be very extensive before they result in incompetence of the kidneys. One of the common causes of destruction of tissue and of later degenerative changes in the kidney are inflammations that have occurred in earlier years.

Pyelitis

Pyelitis is caused by the localization and multiplication of bacteria in the kidney. The organism most frequently responsible is the *Bacillus coli communis*, a normal inhabitant of the intestinal tract. Staphylococci, and Streptococci and the *B. tuberculosis* are also common invaders of the kidney. It used to be supposed that the kidneys almost always became infected by an ascending infection from the bladder. Such ascending infection has been experimentally demonstrated. In the guinea pig, when the urethra is partially obstructed, or the nervous mechanism of urination disorganized, the introduction of pathogenic organisms into the badder is followed within two or three hours by the ascent of these organisms along the ureter into the pelvis of the kidney. This ascent can also be demonstrated by means of carmine particles. Obstruction of the urethra occurs most frequently in young men from strictures caused by gonorrhoeal inflammation. In old men it is often caused by enlargement of

the prostate gland. In both cases infections of the bladder and kidney are common. Pyelitis is rather more common in women than in men, probably because bladder infections are more readily acquired by women. It is now believed that many cases, perhaps even the majority of cases of pyelitis, are the result of blood infections that have become localized in the kidneys. Infection of the kidneys undoubtedly occurs in both of these ways.

Acute pyelitis causes the usual general symptoms of any infection with the production of pus: namely, irregular fever, chills and sweats. There is often pain in the back or tenderness on pressure over the kidney area. Unless the bladder is or becomes infected, there are often no urinary symptoms. Frequent and very painful urination indicates infection of the bladder. If the urine is examined, pus, red blood cells and bacteria will be found, and the variety of bacteria can be identified. If the infection is sufficiently severe, it may cause death, but usually the acute symptoms subside and the condition becomes chronic. These chronic infections of the kidneys may last for years and eventually produce a great deal of destruction of kidney tissue.

The diagnosis of this condition depends chiefly upon the examination of the urine and upon a direct examination of the kidney by means of the cystoscope with ureteral catheterization and the use of the x-ray. The cystoscope is a tubular instrument that can be inserted into the bladder and by means of a small electric bulb the bladder walls are made visible. The ureteral orifices are readily seen and fine catheters may be passed into them so that urine may be collected from each kidney separately. In this manner it is possible not only to learn whether both kidneys are infected but also to apply local treatment to the infection by injection of antiseptics such as silver salts and mercurochrome, a recent highly bactericidal product of chemotherapy containing mercury combined with a dye. X-ray photographs of the kidney and ureter may be taken, especially after impregnation of these structures with certain salts of the metals which are impervious to the x-rays. By this means the extent of the injury caused by the inflammatory process may be estimated, and stones in the kidney may be seen. Such stones are caused by the

deposition of urinary salts upon clumps of bacteria, and are a frequent complication of kidney infections.

Internal medication may also be used. Until recent years this was the only method of treatment possible and was generally quite useless. But in 1924 the new drug hexylresorcinol was introduced. This drug is several times more bactericidal than carbolic acid, but is not irritating and is excreted through the kidneys. By the use of hexylresorcinol many kidney infections can be completely relieved, the infecting organism being killed and the urine becoming sterile. With this drug and the modern local treatment there is no longer any necessity for the long years of invalidism that so frequently used to follow kidney infections, and this should have a marked effect in the reduction of the frequency and intensity of later degenerative changes.

Acute nephritis

Acute nephritis may occur at any age, but is seen more often in children and young adults. Many injurious agencies cause acute nephritis.

1. Acute infections. Almost any of the acute infectious diseases may cause inflammation of the kidney, but in certain infections it is a very common sequel. This is particularly true of scarlet fever. Tonsillitis is also a frequent cause of acute nephritis. Measles is less apt to cause nephritis. Syphilis is responsible for some cases.

In the management of these acute infections and particularly of scarlet fever, the possibility of acute nephritis must always be remembered, the urine should be examined, and if any abnormality exists, treatment should be directed to minimize the injury, and a long period of rest in bed on a suitable diet should be insisted upon. Under these circumstances complete recovery from acute nephritis is the rule. When proper care is not taken the condition may result fatally, but more often passes into subacute or chronic nephritis.

2. Poisons. Various poisons that are irritants to the kidneys cause acute inflammation. Turpentine, mercuric chloride, carbolic acid, arsenic and lead are such poisons. Workers in turpen-

tine, lead and similar irritating chemicals should use particular care to avoid absorption. Acute nephritis is the chief cause of death in cases of mercuric chloride poisoning. Alcohol cannot produce acute nephritis, although its long continued use may undoubtedly cause degenerative changes in the kidney.

Certain poisons produced in the body undoubtedly cause acute nephritis. This is a frequent complication of pregnancy, so that careful obstetricians insist upon frequent urine analyses throughout the duration of pregnancy and weekly examinations during the later months. The real cause of the acute nephritis of pregnancy is unknown, but much evidence has accumulated indicating that it is caused by poisonous products resulting from a disturbed metabolism. Acute nephritis also occurs after burns with extensive destruction of the skin, and the absorption of poisonous decomposition products. These cases generally die.

The symptoms of acute nephritis appear suddenly. There may be some fever, pain in the back, and vomiting, and in children convulsions may occur. These symptoms are not characteristic. The most important symptom is a great diminution in the quantity of urine, which is highly colored and contains albumen and blood, often in very considerable quantities. In very severe cases there may be suppression of urine; that is, no urine at all may be passed for a day or two. As a result of this interference with excretion of waste, oedema or dropsy occurs. Swelling of the face and eyelids, and ankles occurs first, but if the nephritis continues the dropsy may become general. Acute nephritis except as the result of mercury poisoning and extensive burns does not often result in death, and as improvement occurs, the amount of urine passed increases, and the dropsy disppears.

All such cases should be under medical supervision and should remain in bed for some time after apparent recovery in order to minimize the injury to the kidney and to prevent the inflammation from passing into the subacute and chronic stages.

Chronic nephritis

This is essentially a degenerative process. The causes of chronic nephritis are not fully understood, but so far as known they may be classified under the following heads:

1. A previous acute nephritis. In a certain proportion of cases recovery from acute nephritis is not complete. The acute symptoms subside, and recovery is apparently complete, but a chronic inflammation persists. This low grade inflammation causes no symptoms until it has lasted for some years and a considerable amount of kidney tissue has been destroyed. Even in those cases in which recovery is complete as shown by the secretion of normal urine containing no albumen, casts or other evidences of inflammation, it is possible that the acute inflammation has damaged the cells in some manner, and that as the result of this damage, they are more liable to degenerative processes.

2. Arteriosclerosis. When the vessels of the kidney are affected the nutrition of the organ is impaired and the cells undergo degeneration. This subject has already been discussed.

3. Other causes. In many cases, perhaps the majority of cases, no specific cause can be assigned for the degenerative process. Nevertheless there are many unfavorable influences that are believed to favor degeneration of kidney epithelium. First among these must be placed high living. The habitual consumption of too much and too rich food, especially a high protein diet, and the habitual use of alcohol undoubtedly acts as a predisposing cause if it does not actually produce chronic nephritis. Gout, a metabolic disease induced by high living, is generally recognized as a cause of degeneration of the kidney, and chronic nephritis is more frequent among those who are overweight. Syphilitic infections, and the prolonged mercurial and arsenical treatment necessary in their treatment may be a possible cause. Certainly chronic lead poisoning causes degeneration of the kidney and it is probable that other forms of chronic poisoning exert an unfavorable influence. In certain cases it may be the result of senility. No tissue cells are everlasting, and in this case the inevitable degenerative changes simply begin first in the kidney epithelium.

However produced, degenerative changes in the epithelium of the tubules and replacement by fibrous tissue result. In the early stage of this process, the kidney is often larger than normal, but as the degeneration progresses, and especially as the fibrous

tissue contracts, the kidney becomes much reduced in size, the fibrous capsule surrounding it becomes thick and adherent, and the organ becomes hard and firm. The external surface becomes rough and granulated, because of the contraction.

Symptoms. There are two types of chronic nephritis, one corresponding to the stage before contraction has occurred, and the second resulting from the typical contracted or cirrhotic kidney. In the first stage known as chronic parenchymatous nephritis, the tubules are distended, and filled with the products of cellular degeneration which are known as casts. These pass out into the urine where they may be seen on microscopical examination, and are classified as hyaline, granular, waxy, etc., according to the character of the degenerative change affecting the cells of the tubules from which they are derived. The urine is diminished in quantity and contains considerable albumen, numerous casts and often both white and red blood cells. As the quantity of urine is diminished, there is retention of water and salts in the body and oedema or dropsy. This has been termed the wet form.

After this condition has lasted several years, the kidney becomes contracted, and the condition that then occurs has been called chronic interstitial nephritis. But especially when caused by arteriosclerosis or senile changes, the characteristic group of symptoms begins insidiously and almost imperceptibly, without any of the preliminary symptoms of chronic parenchymatous nephritis already described. This group of symptoms resulting from chronic interstitial nephritis includes: an increase in the amount of urine passed and increased frequency of urination, with increased thirst; increased blood pressure; digestive disturbances; and most striking of all reduced visual acuity may be an early symptom. This is caused by a well known degeneration of the retina, called albuminuric retinitis, that may result in total blindness. For unless the kidney condition can be relieved, albuminuric retinitis is a progressive condition with no tendency to recovery.

The first symptom usually noticed is the passage of an increased amount of urine especially at night so that it may be necessary

to get up several times. This urine is pale, contains but a small quantity of the substances that should be excreted, and so has a low specific gravity, and when examined may show traces of albumen, but no large quantities, and but a few transparent or hyaline casts. On physical examination, the blood pressure is found to be increased, the pulse is hard, and often the heart is enlarged. It is as the result of this increased blood pressure, that so much urine is secreted, and therefore in this type of nephritis there is seldom much if any oedema. On the other hand, urea, uric acid and other nitrogenous waste products are not being excreted as they should, they accumulate in the body and this results in a chronic toxaemia that at any time may become acute. This form of nephritis therefore causes most of the fatalities that are collected in the mortality statistics under the rubric chronic nephritis. The acute toxaemia resulting from the incapacity of the kidneys to excrete waste products is called uraemia.

Uraemia

Uraemia is manifested by a group of symptoms. In some cases one set of symptoms predominates, and at other times another set is more important. These symptoms may be classified as:

1. Convulsions which may occur suddenly or may be ushered in by muscular twitchings lasting for several days before the real convulsion. Such convulsions may be continuous and end in death, or may pass away only to recur at intervals.

2. Coma—or a deep unconsciousness from which the patient cannot be aroused. This may persist for days. The breath of such a comatose patient often has a urinous odor.

3. Mental changes which may result in maniacal excitement or delusions. Such patients have often killed themselves as the result of delusions of persecution.

4. Dyspnoea or gasping for breath, which is paroxysmal, often occurring at night. These attacks closely resemble ordinary asthma, and sudden attacks of asthmatic breathing in an individual who has never previously been subject to asthma, should suggest the possibility of chronic nephritis and should

lead to an examination of the urine. This disturbance of the respiration is caused by the accumulation of acids in the blood which should have been eliminated.

5. Gastro-intestinal symptoms. Vomiting and diarrhoea are common symptoms. Both may be prolonged and more or less uncontrollable. They are possibly attempts of the body to eliminate substances that should have been eliminated by the kidney route.

It may be seen therefore that in nephritis there are two abnormalities. The kidney permits the passage of substances that should be retained, like albumen and blood, and which may therefore be found in the urine; and it retains substances like urea and uric acid that should be excreted, and which may be detected in the blood. Both urine and blood should therefore be examined. There has been a great development of blood chemistry in recent years. Blood is withdrawn from a vein with a syringe, and submitted to various chemical tests, by means of which the amount of non-protein nitrogen, urea nitrogen, uric acid and creatinin are determined. The amount of urea nitrogen normally present in the blood is from 12 to 15 mgm. per 100 cc. of blood, and this may be increased to 50 mgm. in chronic nephritis and to 80 to 300 mgm. in uraemia. A normal content of 1 to 2.5 mgm. of uric acid may be increased to 4 mgm. in chronic nephritis and to 15 mgm. in uraemia. The limits of creatinin excretion are narrower. A normal content of 1 to 2.5 mgm. may be increased to 3 mgm. in nephritis and to 5 mgm. in uraemia. The excretion of creatinin is the last kidney function to be impaired. Therefore when the amount of creatinin excreted is normal, the condition is more hopeful than when this substance is retained in the blood. The finding of a large amount of creatinin in the blood of a nephritic patient is a bad sign that almost invariably presages an early death.

Another very important test to determine the degree of kidney degeneration is the so-called kidney function test. This consists in the hypodermic injection of a red dye, phenolsulphonephthalein, which is excreted through the kidneys. The urine is collected at the end of one hour and two hours, and the proportion of the

dye excreted is determined. Normally 60 per cent of the dye should be excreted at the end of two hours. Any considerable reduction in this percentage indicates impairment of kidney function, and it has been found that inability to excrete this dye runs very closely parallel with inability to secrete urea.

Prevention

Degenerative disease of the kidney cannot be entirely prevented, but it can be distinctly limited, by the adequate treatment of all cases of acute nephritis, and by living a normal life in accordance with the well known hygienic principles. After chronic nephritis has commenced, much can still be done to prolong life by the adoption of special diets, by climatic changes and careful medical supervision. All such cases should be under continuous medical care from the time the condition is first detected. The detection of this degenerative process at the earliest possible time is a natural consequence of periodic examination of apparently healthy individuals, the importance of which is thus further emphasized.

Diet

Nephritis has been produced in experimental animals by removing part of the kidney tissue and functional overstrain of the remainder. Such experimental work appears to indicate that chronic nephritis results from the action of primary and secondary causes. Infections or intoxications produce the initial lesions, destroying a certain proportion of kidney tissue. The degenerative processes that occur later are caused by functional overstrain of the remaining tissue.

If this theory is correct, chronic nephritis does not necessarily run an inevitable course. There is only a certain amount of normal kidney tissue left. The diet must be reduced and the whole manner of life must be altered so that the kidney remnant will be able to effect a total excretion sufficient to keep the blood at the normal levels for these excretory substances. If this cannot be done the degeneration is progressive and eventually fatal; if it can be done, the symptoms of nephritis disappear, and

the degenerative process ceases. It has been found in practice that this may often be accomplished by a great restriction in the amount of salt or what is often called a salt free diet although no diet is entirely devoid of salt. A salt free diet is also one of the most effective means of reducing high blood pressures, and the arteriosclerosis caused by hypertension.

Climate

Bundeson and Falk (*Journal American Medical Association*, December 11, 1926) have found from a study of the vital statistics and weather records of Chicago from January 1, 1924, to April, 1926, that the mortality from chronic nephritis and also from organic diseases of the heart and from cerebral haemorrhage is unusually high when the temperature is low, and is low when the temperature is high. This statistical demonstration of the unusual danger of cold weather for those suffering from these degenerative diseases is quite in harmony with general medical opinion, and physicians have always advised such patients to avoid cold winters and to live in a warm equable climate whenever possible.

The reason for the desirability of a warm climate is also clearly understood. Blood pressures of white men living in the tropics are reduced on an average from 10 to 15 mm. of mercury below those normal for the temperate zone. Less food is required in order to maintain the body temperature, and the basal metabolism is at a lower level. Although these factors may cause some reduction in the energy exhibited by young and vigorous individuals who go to the tropics, they are of obvious advantage to patients suffering from degenerative diseases, reducing the strain on arteries, heart and kidneys.

CIRRHOSIS OF THE LIVER

Cirrhosis or hardening of the liver is the most frequent and most fatal of the degenerative processes affecting the digestive organs, but as compared with heart diseases, cerebral haemorrhage, nephritis and arteriosclerosis, it is relatively unimportant.

The crude death rates per 100,000 for cirrhosis of the liver in the registration area are as follows:

Year:	1900	1910	1915	1920	1921	1922	1923	1924	1925	1926	1927
Rate:	12.9	13.9	12.6	7.1	7.4	7.5	7.2	7.4	7.3	7.2	7.5

Cirrhosis results when the liver cells degenerate and die and are replaced by fibrous tissue. There are two types of the disease. In the first, called atrophic cirrhosis, the connective tissue is deposited as bands of fibrous tissue between the lobules of the liver, and when these contract, the liver shrinks to much less than its usual size. In the second type called hypertrophic cirrhosis, a larger amount of connective tissue is deposited in the lobules as well as between them and the size of the liver is increased. In both types, when the liver is examined after death, it is found to be abnormally firm and hard and is cut with difficulty, the knife often making a creaking sound as it passes through the organ. The liver is often of a yellowish color instead of its normal deep red color, hence the name cirrhosis which means tawny yellow.

The causes of cirrhosis of the liver are not fully understood but some of the causes are well known. Perhaps the most frequent cause of atrophic cirrhosis is chronic alcoholism. All of the veins leaving the intestine and carrying the absorbed products of digestion, are united into one large vein, the portal vein which passes through the liver. Alcohol is absorbed unchanged and therefore passes directly through the liver before entering the general circulation. An occasional indulgence does little harm, but in steady drinkers, particularly of distilled liquors which have a high alcoholic content, the liver cells are continuously soaked in alcohol and degenerate.

But alcohol is by no means the only cause of cirrhosis which has often occurred in total abstainers. Infections are a frequent cause. Colon bacilli, the common inhabitants of the intestinal tract may enter the blood from the bowel and be deposited in the liver where they cause a constant mild inflammation. Intestinal bacteria may also enter the bile ducts and are particularly apt to multiply there when the flow of the bile is interrupted, as by

impacted gall stones. Syphilitic infection is very apt to affect the liver where it may produce either a diffuse chronic inflammation or gummas which cause considerable local destruction of tissue. Extensive destruction of liver tissue also occurs as the result of certain poisons like chloroform. This is a serious danger when chloroform is used during long operations, and is one of the reasons why ether is preferred as an anaesthetic. The so-called toxaemias of pregnancy, like pernicious vomiting are associated with extensive destruction of liver tissue although it is difficult to say whether the degeneration of the liver is primary and causes the toxaemia, or if the toxaemia causes the destruction of the liver cells.

There are numerous cases in which none of these explanations will serve. For instance there is a well recognized form of cirrhosis of the liver occurring in infants and young children in India, and believed to be caused by stuffing these children with starchy foods and sweetmeats. Cirrhosis of the liver is also very common among Filipinos, a race that is very temperate in the use of alcohol. It has been suggested that many of these cases may be explained by the excessive use of highly spiced foods.

It seems more probable that these unexplained cases of cirrhosis of the liver may be produced in a manner similar to that already described for chronic nephritis. That is, there is a primary destruction of liver tissue by some of the well known infections or intoxications and thereafter a functional overstrain of the remaining liver tissue causes progressive degeneration. This functional overstrain is caused by the consumption of a diet which is beyond the capacity of the liver to metabolize. The liver stores and serves as a chemical laboratory for metabolizing both fats and carbohydrates, and also synthesizes urea from the protein waste of the body, in addition to secreting bile for use in the process of digestion. These multifarious duties are all concerned with the utilization of food, and an excessive diet may well overwhelm the liver and cause degeneration of its cells.

The symptoms of cirrhosis of the liver

In accordance with the importance of its functions, the liver is the largest gland in the body, its size equalling all the other

glands put together. In the adult it has a volume of about 100 cubic inches and a weight of from 40 to 60 ounces. This huge gland has a considerable factor of safety, and a large portion of it may be removed by operation or destroyed by disease without producing any symptoms. Therefore the early stages of cirrhosis produce no symptoms.

Atrophic cirrhosis

In the late stages of this variety of cirrhosis when the liver is markedly shrunken, the symptoms are both obstructive and toxic. The blood can no longer pass freely through the contracted organ. If a collateral circulation can be established, even extreme cases of cirrhosis may produce no symptoms. This collateral circulation is formed by a great enlargement of the superficial veins of the abdomen and chest, known as a *caput medusae*, a reference to the head of the mythological gorgon with the snaky locks. Through these enlarged superficial veins, the venous blood can circulate from the extremities without passing through the liver. In the absence of a sufficient collateral circulation, the blood in the internal veins is obstructed, the veins themselves become dilated, and the organs drained by them are congested. Overfilling of the veins of the stomach causes gastric catarrh with nausea and vomiting. Sometimes these veins rupture, and profuse haemorrhage from the stomach occurs. This is very alarming but is seldom fatal. In a similar manner the rectal veins are dilated with formation of haemorrhoids or piles, and bleeding. The obstruction to the portal vein results in an accumulation of serous fluid in the abdomen, which goes by the name of ascites, and which may amount to 15 to 20 quarts, causing great abdominal distention and discomfort. This may be relieved by tapping. A large size needle is inserted and the fluid allowed to run out; but this measure is only palliative, for the fluid accumulates again and again.

The toxic symptoms are caused by inability of the liver to form sufficient urea or to fulfill its other function of removing toxic substances, which accumulate in the blood. The toxic symptoms so produced are very similar to those of uraemia,

including convulsions, delirium and coma. Jaundice is usually slight but occurs in about one-third of the cases. The majority of cases of atrophic cirrhosis occur between thirty to sixty years of age, and death occurs at an average of forty-eight years. About 78 per cent of the cases are males, and 26 per cent females.

On the other hand, cases of hypertrophic cirrhosis with enlarged liver, usually occur in young people, but again more frequently in males. Alcohol plays no part in the production of this form of cirrhosis. The disease develops gradually lasting for from four to ten years. The symptoms are similar to those already described except that ascites does not occur, but jaundice almost always does and is more pronounced. There is often pain in the region of the liver, and the greatly enlarged liver is easily detected below the border of the ribs.

Prevention

Cirrhosis of the liver may be prevented by the avoidance of the causes described as producing it, namely, a proper diet, avoidance of the alcoholic habit, and of infections. The chief cause of gall stones, one of the main causes of obstruction of the bile ducts, is typhoid fever. The typhoid bacillus is unusually apt to become localized in the gall bladder, where it causes inflammation of the lining membrane. It is because of this infection of the gall bladder that typhoid patients so frequently become carriers. The typhoid bacilli also often become agglutinated or form clumps, and these clumps serve as foci upon which certain ingredients of the bile such as cholesterin and bile salts are deposited. In time these depositions attain a considerable size when they are known as gall stones. Gall stones are usually multiple and vary in size from a quarter to half an inch in diameter.

As at the present time the infections are being controlled, alcoholics are becoming less numerous, and the sylph-like figures demanded by modern fashion are conducive to more moderate habits of eating, it seems probable that in future years the results of these improved conditions may be manifested, among other ways, in greatly reduced rates for cirrhosis of the liver.

From what has been said, it may be concluded that although the rates for the degenerative diseases as a whole show no decrease at present, and in some cases are actually increasing, the situation is far from hopeless. The rates for degenerative diseases today are the results of conditions existing from twenty to forty years in the past, and present day improvements will not produce reduction of these rates until from twenty to forty years in the future. With the present high rates for degenerative diseases, and with this hope clearly before us, it is increasingly evident that the greatest possibility for future progress in the preservation of health and life extension depends upon the universal education of the individual with regard to the rules of personal hygiene, and upon a modification of present day medical practice. Physicians should be employed primarily to keep people healthy, and only secondarily to treat them after they have become sick. This latter idea will be developed further in a later chapter.

PART II. PRESENT ACCOMPLISHMENT IN DISEASE PREVENTION AND THE PROBLEMS OF THE FUTURE

CHAPTER VI

The Conquest of Disease and the Increase in the Span of Life

The average length of human life in the sixteenth century was between eighteen and twenty years, and at the close of the eighteenth century, it was still less than twenty-five years. (*Hygeia*, July, 1925.) At the close of the nineteenth century it was between forty-five and forty-eight years, nearly double that of one hundred years previously.

No single cause will account for this great increase in the span of life during the comparatively short period of one hundred years, but the most important cause is undoubtedly the great reduction of infant mortality and the conquest of infectious diseases, particularly the major pestilences such as plague, smallpox, typhus, cholera and yellow fever. The heavy mortality caused by the above diseases is almost inconceivable to people living today under modern sanitary protection, where epidemics of these diseases have never occurred in the memory of those living. Modern sanitation owes its origin chiefly to the terror inspired by epidemics of these infectious diseases.

It may be interesting to present a picture of what occurred before these diseases were controlled. The greatest epidemics of which we have knowledge are those of plague.

BUBONIC PLAGUE

Bubonic plague, or the black death, occurred in antiquity, and it is believed that 41 epidemics occurred during the fifteen hundred years before the Christian era. There were 109 epidemics during the first fifteen hundred years of the Christian era and 45 epidemics between 1500–1720 A.D.

In the time of Justinian (542 B.C.), a great epidemic extended

over the then inhabited earth, and lasted for fifty years, appearing and disappearing again and again. Cities were depopulated and in many places the land reverted to the wilderness. The actual mortality cannot be known, but it is estimated at fifty million. In Constantinople ten thousand are said to have died in a single day.

The great epidemic that occurred in Europe about 1348 and described in the *Decameron* of Boccacio also caused a phenomenal record of death. A conservative estimate is that one-fourth of the entire population of the earth, or sixty million people died. This epidemic reached England in 1348 and had extended to Scotland by 1350. From one-half to two-thirds of the population perished. Writers of that day asserted that from two-thirds to three-fourths of the population in certain areas died. Another great epidemic commenced in Europe after 1500 and by 1560 had spread all over Europe breaking out again and again at intervals, and probably killed just as many. In the following century plague again became epidemic. The great plague of London described by Defoe was no greater than many previous epidemics, but was the last great epidemic in London. It carried away 69,000 in a population of less than 500,000, of whom two-thirds had fled to escape the contagion. The Vienna visitation of 1679 took 70,000; that of Prague in 1681 took 83,000, and the Italian epidemic in 1630 numbered 80,000 deaths in Milan, and over 500,000 in the Venetian Republic.

The transmission of plague was facilitated by the lack of all sanitation in those days. Rats swarmed everywhere in incredible numbers and were encouraged as scavengers. One writer living opposite a tan yard noticed one evening the carcasses of thirty-six horses stripped of their hides and thrown into the street. The next morning the bones had been picked clean by the rats. Every house was full of fleas. Pepys records a night at a crowded inn when he shared his bed with one, Master Clark, "who did attract all the fleas to himself, to my exceeding relief."

Plague has not disappeared from the world. There were more than 400,000 deaths from plague in Asia during 1924. But although plague obtained a foothold in the United States about

1900, there has been no extensive epidemic in the United States,[1] or in Europe during the present century, although it is constantly present in India. Prior to the nineteenth century millions and possibly billions of people had died of plague in Europe. The term decimated is often used to designate a very unusually heavy mortality, but plague often took one out of every four of the living. The disappearance of only one disease producing such a mortality must have had a great effect in extending the average length of life.

SMALLPOX

But other epidemic diseases of only slightly less force of mortality were also controlled. Smallpox was a disease that often decimated the population and owing to its repulsive character caused a degree of mental anguish exceeding that produced by any other disease.

Prior to the publication of Jenner's work in 1798, smallpox was one of the most common causes of death in all countries. At the present day, smallpox has been controlled wherever vaccination is enforced. Some idea of the prevalence of smallpox before vaccination was introduced may be obtained from certain old records. Among these is the parish register of Kilmarnock kept from 1728–1764. This town had a population of not more than 4200. The total deaths in thirty-six years were 3860 of which 622 were due to smallpox, or 169 in every thousand deaths. Smallpox was then a disease of children, just as measles now is. In the whole thirty-six years there were only 3 deaths from smallpox in persons over twenty years of age. All others had had the disease and died or recovered. In Cheshire in 1775 in a population of 15,000, only 1060 persons had not had smallpox. In a Hertfordshire village named Ware, in a population of 2515 at the end of 1772, only 302 persons had not had

[1] There was an outbreak of plague in Los Angeles, California in 1924, in which 33 cases of pneumonic plague with 31 deaths and 8 cases of bubonic plague with 3 deaths occurred. Rat and squirrel plague also existed, but the outbreak yielded promptly to plague suppressive measures.

smallpox, and these were tabulated in the parish register under the heading "to have smallpox."

In Edinburgh from 1744–1763 in a total of 11,613 deaths, 1185 were due to smallpox. In Glasgow from 1783–1800 out of 31,089 deaths from all causes 5959 were due to smallpox or 191 per thousand deaths. In London from 1660 to 1679 in every thousand deaths from all causes, 184 were due to smallpox. In France 10 per cent of all deaths were caused by smallpox.

In other countries the mortality was even greater especially when they were isolated so that smallpox was introduced at longer intervals. The disease was introduced into North America in the sixteenth century by the Spaniards, and was partly responsible for their easy conquest of the native inhabitants. In an epidemic in Iceland in 1707–1709, 18,000 persons died from smallpox out of a population of 50,000.

The effect of vaccination was immediately shown. Thus in Glasgow, if the thirty years from 1783–1812 are divided into five equal periods of six years, three before and two after the introduction of vaccination, the decline in smallpox may be noted from the percentage of all deaths caused by smallpox. The figures are as follows:

1783–1788	1789–1794	1795–1800	1801–1806	1807–1812
19.55	18.22	18.70	8.90	3.90

Equally striking were the statistics of the Franco-Prussian War in 1870–1871. The German Army was vaccinated, and lost only 297 men from smallpox, while during the same years there were 129,128 deaths from smallpox in Prussia alone, and the French Army who were not vaccinated lost over 20,000 men from smallpox.

Such figures are repeated in any body of men who are properly vaccinated. Kitasato's figures for the Russo-Japanese War in 1911 show that with smallpox epidemic in Japan, there were only 362 cases and 35 deaths in an army of over a million Japanese soldiers.

But smallpox though greatly reduced in prevalence is far from eradicated, owing to the opposition to vaccination.

In a recent article,[2] Woodward gives the statistics of smallpox in the United States for the years 1913–1923, and says,

"Is there any reason why in eleven years 1913–1923, Ohio should have 51,913 cases of smallpox?"

Washington	24,183
Wisconsin	29,109
Indiana	40,082
Iowa	29,549
Kansas	29,831
Utah	17,852
Oregon	11,999
California	19,702

while

Massachusetts	457
New Jersey	241
Rhode Island	20

"Why did Porto Rico with 1,299,809 inhabitants have but 137 cases during this period, while the state of Washington with about the same population (1,356,621) had 24,183? Every child in Porto Rico must be vaccinated before it is a year old; every child whether successfully vaccinated or not, must be revaccinated at the age of seven, if unsuccessful, this must be repeated in a month and if still not successful, the child must be revaccinated between its ninth and tenth years, and it is further provided that those persons not twenty years of age who have been successfully vaccinated shall be again vaccinated eight years after the last vaccination, and if not successful, again at the end of a month; that all teachers, employees and care-takers of both public and private schools, all employees of railroads, tramways and public vehicles, all proprietors and clerks of hotels and restaurants, all managers and operatives in workshops and factories must produce certificates according to their ages guaranteeing that they have been vaccinated or re-vaccinated, as the case may be, and that no child can attend school without such certificate.

"No state in the Union, with the exception of Rhode Island, has during the last eleven years been so free from smallpox as has Porto

[2] Smallpox in the United States, Insular Possessions, New England and Massachusetts, 1913–1923, by Samuel B. Woodward, Worcester, Mass., *Boston Medical and Surgical Journal*, January 8, 1925.

Rico. The states with approximately equal populations, namely, Nebraska, Washington, Connecticut, Maryland and West Virginia report

	Cases
Nebraska (since 1918)	14,521
Washington	24,183
Connecticut	4,493
Maryland	1,867
West Virginia (since 1919)	9,321

while Porto Rico had but 137,—109 of these in one epidemic lasting but a few months in 1916."

The disease is even increasing in frequency. In the United States and Canada in the areas for which information was available, cases of smallpox have occurred as follows:

		Falatity rate
1922	30,281 cases	1.62 per 100
1923	29,137 cases	0.52 per 100
1924	52,395 cases	1.78 per 100
1925	38,166 cases	1.89 per 100

One-fifth of all the cases reported in the world during 1923–1924 were from the United States. This is a disgraceful situation, for if one fact has ever been demonstrated, it is that systematic vaccination of children and revaccination of adults will eradicate smallpox. Here then is a disease that might become extinct if vaccination were universally practised during even one generation. But we may expect the continuance of the disease so long as the false teaching of those opposed to vaccination is allowed to counteract the efforts of sanitary authorities.

Another disease that competed with smallpox for preeminence as a killing disease, was typhus fever, variously known as camp fever, jail fever and ship fever.

TYPHUS FEVER

Typhus fever was undoubtedly present during the middle ages, but we have no record of it then for it was first described by Fracastorius in 1533, when it devastated Italy. Being transmitted by lice, we are not surprised to find that in all its history typhus has always been associated with overcrowding, famine,

and privation, and the spread of this disease was facilitated by the universal lack of personal cleanliness. Even kings had no bathrooms or washstands and seldom washed at all. A Belgian medical authority in the eighteenth century, advised that if bathing is too difficult an undertaking, people ought to put on clean linen at least once every six weeks. Under these circumstances, the entire population was lousy, nor was this considered a disgrace. The habit of shaving the head and using wigs was at least partly due to the necessity for obtaining comfort during the night when the wig was laid aside. Also owing to the close personal contact in camp, typhus always followed armies, and war was practically continuous in some parts of Europe. During the Thirty Years' War (1619–1648) typhus was continually present. During the eighteenth century there were three great epidemics. In one year from 1740–1741, 80,000 Irish died of famine and typhus, and one-fifth of the population of Munster died.

Nor was there any appreciable improvement during the first half of the nineteenth century. It is estimated that from 200,000 to 300,000 persons died of typhus in Germany 1813–1814, and the disease was constantly present in Great Britain. In Glasgow in 1837 there were 2180 deaths from typhus and the general death rate was 41 per 1000. So late as 1847, the deaths from typhus fever in Glasgow were 4346 with a total death rate of 56 per 1000. (McVail.) In the Crimean War (1853–1856) 16,000 English, 80,000 French, and 800,000 Russians died of typhus. In the Italian campaign of 1861 and the Turco-Russian War of 1878 there were over 100,000 cases with 50,000 deaths.

Typhus was introduced into Mexico by the Spanish and in epidemics recorded in 1545, 1575 and 1736, 192,000 are said to have died. (Tice.) Typhus was introduced into the United States by Irish immigrants in 1850, and there have been several epidemics though the disease has never spread in the United States as it has in Europe. In 1881–1883 it occurred in New York and Philadelphia with over 700 cases in New York. The last epidemic occurred in New York in 1892. It was then supposed that the disease was eradicated but in 1910 Brill described cases

in New York supposed to be atypical typhoid. This so-called Brill's disease is now known to be mild endemic typhus which has since been reported from a number of other states.

Typhus exists in this form in peace times in most European countries, and reappeared in epidemic form during the great war. In the Serbian epidemic of 1914–1915, 135,000 or about one-tenth of the population died of typhus. Over 200,000 died in Roumania, and during the World War it has been estimated that 1,000,000 people died of typhus. It is probable that such a visitation will never occur again, for the method of transmission is now thoroughly understood.

CHOLERA

Cholera has invaded Europe and the United States, and the mortality caused by it in these countries in the past is only limited by the fact that it was only comparatively recently introduced from Asia. The first epidemic of cholera reached Europe in 1830, advancing through Afghanistan and Persia to Russia. It swept over the entire continent reaching Britain in 1832, and from there it crossed the Atlantic to Canada and the United States. This epidemic did not die out until 1839. Since that time there have been at least five European epidemics; the most recent being that of 1892–1895. An idea of the mortality caused by cholera may be obtained from the following figures: In Hamburg in 1892–1893 out of a population of 640,400 there were 16,957 cases with 8606 deaths, or 264.8 to every 10,000 people.

Between the first appearance of cholera in the United States in 1832 and the last in 1873, there were eight epidemics of varying degrees of severity.

Cholera is constantly present in India, the home of the disease, where it caused more than 276,000 deaths in 1924, but there is every reason to believe that the disease is fully conquered in the United States, and the greater part of Europe. Russia alone still continues to suffer from it.

YELLOW FEVER

Yellow fever is another epidemic disease that only a few years ago was periodically introduced into the United States, when whole areas of our Southern States would be devastated and people fled from their homes to escape it. These epidemics occasionally spread as far north as Philadelphia or Boston. The home of yellow fever may have been either the West Indies or the coast of Africa, but we will never know which one with certainty as the early history of yellow fever is enveloped in obscurity. The disease was first clearly described in 1635. Although introduced several times into Europe, it never has gained a foothold there, because conditions do not favor the Aedes mosquito that alone can transmit it.

Some idea of the annual toll of yellow fever may be gained from the following: In New Orleans in 1853, 7970 people died of yellow fever, and 3093 in 1867. In Rio de Janiero yellow fever took 4160 in 1850; 1943 in 1852, and 1397 in 1886. In Havana, the annual mortality from yellow fever used to range from 500 to 1600 or over. The most extensive epidemic to visit the United States was probably that of 1878 which spread to 132 towns in eight states with more than 74,000 cases and 15,934 deaths. The disease obtained a foothold in New Orleans for the last time in 1905 and although 3000 cases occurred, it was soon controlled and did not spread. No such epidemic will ever occur in the United States again in all probability.

For following Reed's proof that the disease was transmitted by infected Aedes mosquitoes, in a few months Gorgas eliminated yellow fever from Havana, where it had been constantly present for one hundred and fifty years. Gorgas subsequently eliminated yellow fever from the Canal Zone.

The great ease with which yellow fever can be controlled is chiefly owing to the fact that the virus is present in the blood of the patient only for the first three days of the disease, and the survivors are not only free from germs, but are immune against a second attack of yellow fever. Under these circumstances, the disease would soon die out by itself in any single locality,

providing no non-immune individuals come in from the outside to keep the infection going. Also the mosquito that transmits yellow fever is a house mosquito, usually breeding in cisterns, water barrels, or other water near human habitations, and is therefore readily destroyed.

FIG. 1. YELLOW FEVER STEADILY RETREATING FROM THE WESTERN HEMISPHERE

Having demonstrated that for these reasons yellow fever could be quickly eradicated in any single community, it occurred to Gorgas that this was one disease that might readily be made extinct. For yellow fever occurred constantly only along the littoral of the Americas and on the west coast of Africa. If one infected focus after another was attacked and the disease eradi-

cated as it had been in Havana, the Canal Zone and the United States, with each year there would be less chance of the infection spreading, and the time would soon come when it would be eradicated in its last stronghold. If this should occur, the parasite causing yellow fever would become extinct, just as dinosaurs and dodos have become extinct. No living thing that becomes extinct can ever be propagated again, and parasites and bacteria are no exception to this rule. Therefore, if the parasite once became extinct, yellow fever could never occur in the world again, no matter how many mosquitoes there were, for none of them could become infected.

The Rockefeller Foundation has taken up this work and with its large means has organized this fight against yellow fever, acting with and assisting the sanitary authorities of the various infected foci. Yellow fever has now almost been pushed off the American continents and if not extinct like the dinosaurs, is on the road to extinction like the American bison.

Figure 1 taken from the 1924 report of the Rockefeller Foundation, shows how yellow fever is being steadily eradicated from the Western Hemisphere.

"Yellow fever surveys made during 1925 in Venezuela, Peru, Ecuador, and the Central American countries showed these regions to be entirely free of the disease. The only area in the Western Hemisphere in which three yellow fever cases were reported in 1925 was the northern part of Brazil. Campaigns against the yellow fever mosquito were conducted in eleven of the Brazilian states and, as a precautionary measure, in the Central American republics of Salvador, Guatemala, Nicaragua, and Honduras. During the year a yellow fever commission was sent to West Africa to make surveys and laboratory studies in that region." (*International Health Board Bulletin*, January, 1926.)

LEPROSY

Asia is the home of leprosy, and it is believed that it was introduced into Europe by Pompey's soldiers. However introduced, a disease called leprosy spread rapidly until by the thirteenth century both church and state were moved to take stringent measures against this disease. It was undoubtedly

spread by contact, and isolation of those affected was practised. During the thirteenth century Europe became dotted with 19,000 leper hospitals or lazar houses.

It is now known that leprosy is contracted with difficulty, usually only after long and intimate contact with lepers, and the accounts of that disease in Europe during the thirteenth century are so different from what we know of the epidemiology of leprosy today, that many physicians believe that the so-called leprosy of the Middle Ages was largely syphilis.

Some believe that syphilis was an American disease and was introduced into Europe by the sailors of Columbus. But there is little evidence for this, and more reason for believing that syphilis is a very old disease. The fact that gonorrhea and syphilis were believed to be different phases of the same disease by some physicians in the nineteenth century, and that the causal organism of leprosy was only discovered in 1874 and that of syphilis in 1905 shows that the diagnosis of leprosy in the thirteenth century was thoroughly unreliable. Whatever this disease called leprosy may have been, it was exceedingly common in the middle ages.

As a result of this enforced isolation and of the general advance in economic conditions and social customs, leprosy diminished rapidly during the fifteenth century, and between 1656 and 1662, Louis XIV of France was able to abolish the leper hospitals and devote their endowments to charity and general hospital construction. This practical eradication of leprosy in Europe must have contributed materially to the lowering of the enormous death rates of the Middle Ages. The disease that we now know as leprosy has been controlled in Europe and the United States as may be seen from the fact that there are only 200 lepers registered in the United States, although there may be from 500 to 1200. But India is estimtated to have 1,000,000; Japan 40,000, and there are at least 10,000 lepers in the Philippine Islands to 10,000,000 population. This is 1 to every 1000 inhabitants. A prevalence similar to that of the Philippines would give 110,000 for the United States.

Segregation of lepers is still practiced. In the Philippines

lepers have been sent to a leper colony maintained on the island of Culion, and lepers from the Hawaiian Islands are sent to Molokai. Little advance has been made in the control of leprosy by this method, because people object to this separation from their families and conceal the infection. Since the discovery that leprosy is often curable by the injection of chaulmoogra oil and its ethyl esters, it has become possible to so treat lepers at detention stations near their homes. Many are cured and only incurable cases need be sent to such isolated islands. The prospect of cure will undoubtedly cause more early cases to apply for treatment, and the disease will no longer be concealed. Each case so isolated and treated removes a focus of infection, and it is at least possible that in a few years, the incidence of leprosy will be greatly reduced in the Asiatic countries where it is still prevalent. Since the establishment of a Federal leprosarium in the United States in 1920 there is an excellent prospect that isolation and treatment combined will result in the complete eradication of the disease.

Health departments were originally organized chiefly for the purposes of controlling these pandemics that have just been described. As these plagues disappeared, the health organizations turned their attention to other diseases, particularly to tuberculosis and typhoid. A great impetus was given to this work after 1880 by the development of the science of bacteriology and the discovery of the method of transmission of many of the commonest infectious diseases. During the same period the collection of vital statistics, especially the records of births and deaths improved to such a degree that health officials were able to see the results of their efforts as never before.

TABULATION OF DEATH RATES

The results attained by preventive medicine may be shown by death rates. Crude death rates are misleading unless the percentage composition of the population remains practically constant. Death rates are low in a community composed chiefly of young adults, and high when a community is largely composed of the very young and the very old. But in any country the

composition of the population changes slowly, and sudden large differences in death rates are significant.

For about fifty years, corresponding with the development of scientific medicine and sanitation, there has been a general downward trend in the death rates of almost all civilized countries. This is well shown by the death rate in Sweden, a country where vital statistics have been collected for many years (see table 21).

A similar reduction has occurred in other countries. The death rate in London in the early part of the seventeenth century (1606–1610) is given as 70 per 1000. The death rates per 1000

TABLE 21

Death rate in Sweden

YEAR	RATE	YEAR	RATE	YEAR	RATE
1750	28.83	1810	31.38	1870	19.80
1760	24.78	1820	24.46	1880	18.10
1770	26.06	1830	24.08	1890	17.12
1780	21.74	1840	20.35	1900	16.84
1790	30.43	1850	19.79	1910	14.04
1800	31.43	1860	17.65	1920	13.29

inhabitants for England and Wales, France and the United States are shown in table 22.

A death rate of 19.8 in 1880 is thus reduced to 11.8 in 1925. The death rate in New York City was 28.3 per 1000 in 1875; in 1925 it was 11.5. The death rate in a total of 65 of the largest cities of the United States whose rates in 1875 were quite as high as those of New York was 13.6 per 1000 in 1923 and 12.5 in 1924.

A similar progressive decrease in recent years, with even lower rates is shown by certain special groups. The death rates of the Metropolitan Life Insurance Company is a case in point. These rates are based on about 15,000,000 insured persons in the industrial department of this Company, and are as follows:

Year....	1913	1914	1915	1916	1917	1918	1919	1920	1921
Rate....	11.99	11.52	11.30	11.68	11.61	15.59	10.63	9.89	8.70

Year.....	1922	1923	1924	1925	1926	1927
Rate.....	8.82	8.97	8.48	8.45	9.49	8.40

The death rate for all causes in the United States Army (*Report of the Surgeon General, United States Army*, 1918, p. 23) composed

TABLE 22

Death rates in England, Wales, France and the United States

YEARS	RATE	YEARS	RATE
1841–1850	22.4	1891–1895	18.7
1851–1860	22.3	1896–1900	17.7
1861–1870	21.3	1901–1905	16.0
1871–1880	21.3	1906–1910	14.7
1881–1885	19.4	1925	12.2
1886–1890	18.9	1926	11.6
Death rate per 1000 for France			
1800–1810	27.7	1871–1880	24.3
1811–1820	26.0	1881–1885	22.2
1821–1830	25.0	1886–1890	22.0
1831–1840	24.8	1891–1895	22.3
1841–1850	23.3	1896–1900	20.7
1851–1860	23.9	1901–1905	19.6
1861–1870	23.6	1906–1910	19.2
		1922	17.5
Deaths per 1000 for the Registration Area in the United States			
1880	19.8	1912	13.9
1890	19 6	1913	14.1
1900	17.6	1914	13.6
1901	16.5	1915	13.6
1902	15.9	1916	14.0
1903	16.0	1917	14.3
1904	16.5	1918	18.1*
1905	16 0	1919	12.9
1906	15 7	1920	13.1
1907	16.0	1921	11.6
1908	14.8	1922	11.8
1909	14.4	1923	12.3
1910	15.0	1924	11.9
1911	14.2	1925	11.8

* Influenza epidemic.

of young adult males, has been similarly reduced. The reduction was gradual from 1820–1869, followed by a phenomenal decrease between 1870–1925 (see table 23).

Many other figures could be quoted, but their general trend is the same, and leads inevitably to the conclusion that the decline in the death rate is world wide, is proportionally greater in the

TABLE 23

Death rates in United States Army (American troops) per 1000 mean strength by decennial periods 1820–1909, and years 1910–1917, and single years 1921–1925

DECADE	DECENNIAL DEATH RATE	YEAR	DEATH RATE
1820–1829	33.6	1910–1917	4.9‡
1830–1839	22.9*		
1840–1849	29.9†	1921	4.67
1850–1859	25.2	1922	4.26
1860–1869	23.4†	1923	4.56
1870–1879	15.3	1924	3.54
1880–1889	9.4	1925	3.75
1890–1899	9.9		
1900–1909	7.7		

* Returns for 1833, 1834, 1836 not obtainable.

† Returns for years, period of Mexican War (1847–1848), Civil War (1862–1866, inclusive), and World War (1918–1920), not included.

‡ Average.

TABLE 24

Expectation of life in United States registration states and in Massachusetts, 1924

AGE	UNITED STATES REGISTRATION AREA			MASSACHUSETTS, 1924		
	Males	Females	Persons	Males	Females	Persons
0	56.74	59.59	58.10	56.67	60.09	58.32
7	56.26	58.07	57.12	56.40	58.76	57.60
12	51.78	53.50	52.59	51.98	54.26	53.14
17	47.42	49.07	48.20	47.50	49.74	48.64
22	43.36	45.00	44.13	43.24	45.39	44.34
32	35.24	36.90	36.02	34.68	36.92	35.82
42	27.32	28.84	28.03	26.51	28.59	27.58
52	19.85	21.18	20.48	18.87	20.74	19.84
62	13.26	14.27	13.75	12.52	13.94	13.27
72	8.18	8.87	8.53	7.83	8.79	8.36
82	4.70	5.01	4.88	4.67	5.04	4.89
92	2.76	2.70	2.73	2.56	2.66	2.58

more enlightened countries and the large centers of population, and that the decrease has been especially marked during the past fifty years.

AVERAGE LENGTH OF LIFE

The reduction in the death rate means that a considerable number of years has been added to the average span of life. In 1800, the average length of life in the United States was 33 years. In 1855 it had increased to 39.77 years. In 1901 the expectation

TABLE 25

Population, deaths and deathrates per 1000, United States Registration States, 1920

AGE PERIOD	ESTIMATED MID-YEAR POPULATION	DEATHS	DEATH RATES PER 1000
All ages—total	86,043.627	1,118,070	12.99
Under 1	1,772,022	170,911	96.45
1	1,835,551	36,106	19.67
2	1,852,486	16,503	8.91
3	1,879,711	11,184	5.95
4	1,832,228	8,306	4.53
5 to 9	8,966,917	26,535	2.96
10 to 14	8,355,822	19,046	2.28
15 to 19	7,416,925	30,276	4.08
20 to 24	7,442,685	42,386	5.70
25 to 29	7,462,571	48,224	6.46
30 to 34	6,727,817	48,600	7.22
35 to 39	6,479,122	50,436	7.78
40 to 44	5,335,665	46,225	8.66
45 to 49	4,846,495	50,438	10.41
50 to 54	4,028,420	56,587	14.05
55 to 59	3,051,838	60,537	19.84
60 to 64	2,544,264	71,462	28.09
65 to 69	1,756,534	75,344	42.89
70 to 74	1,191,366	78,507	65.90
75 to 79	739,270	73,120	98.91
80 to 84	347,470	52,959	152.41
85 to 89	134,657	29,131	216.33
90 to 94	33,531	10,281	306.61
95 to 99	7,589	2,427	319.81

of life at birth was 49.24 years, in 1910, 51.49 years; in 1920, 56.32 years; and in 1924, 58.10 years. There have been added 18.33 years to the average length of life in this country since 1855, and 8.86 years have been added since 1901 (see table 24.)

A similar prolongation of life has occurred in other countries. It may be interesting to know how such figures are obtained.

From the death rates furnished, the specific death rates for each age division of the population are calculated.

Table 25 and figure 2, taken from a paper by Dublin, the statis-

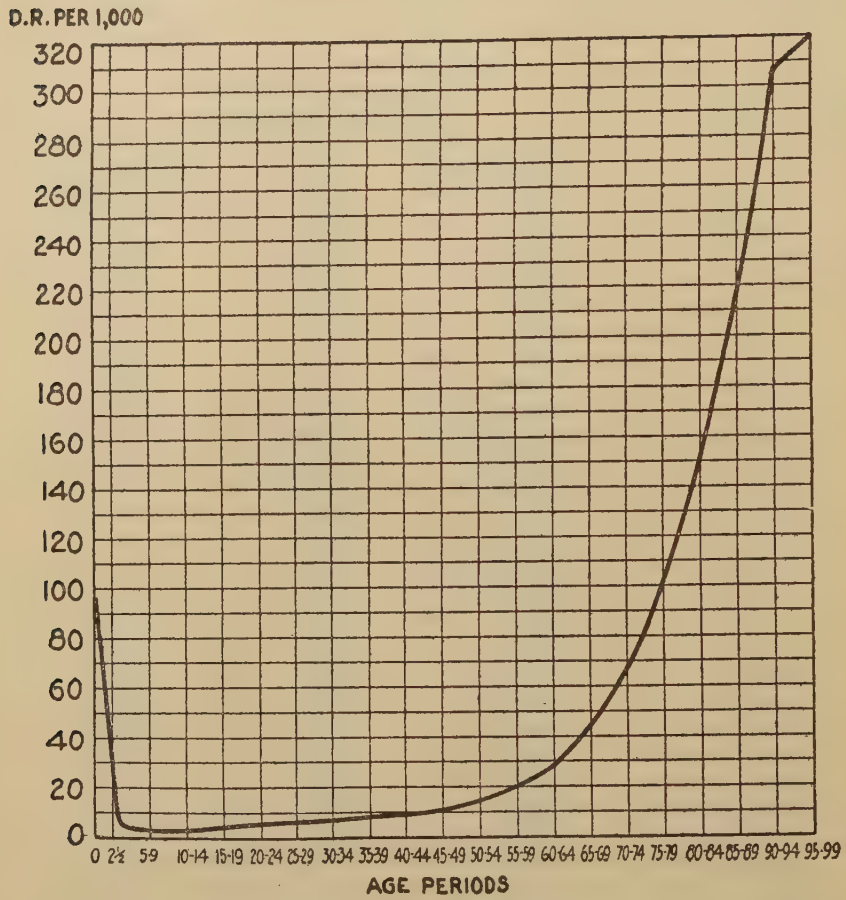


FIG. 2. DEATHS PER 1000 POPULATION AT SPECIFIED AGE PERIODS, UNITED STATES REGISTRATION STATES, 1920

tician of the Metropolitan Life Insurance Company gives a table of specific age death rates for the United States Registration area in 1920, and the characteristic curve obtained when these rates are plotted.

TABLE 26

Life table, 1910—entire population of the original United States Registration States

AGE INTERVAL (1)	NUMBER ALIVE AT BEGINNING OF AGE INTERVAL (2)	NUMBER DYING IN AGE INTERVAL (3)	MORTALITY RATE PER 1000 (4)	TOTAL POPULATION LIVING IN CURRENT AND HIGHER AGE INTERVAL (5)	COMPLETE EXPECTATION OF LIFE (6)
0–1	100,000	11,462	114.62	5,148,536	51.49
1–2	88,538	2,446	27.62	5,056,683	57.11
2–3	86,092	1,062	12.34	4,969,588	57.72
3–4	85,030	666	7.83	4,884,059	57.44
4–5	84,364	477	5.65	4,799,376	56.89
5–6	83,887	390	4.66	4,715,260	56.21
6–7	83,497	327	3.91	4,631,568	55.47
7–8	83,170	274	3.30	4,548,235	54.69
8–9	82,896	234	2.82	4,465,202	53.87
9–10	82,662	204	2.47	4,382,423	53.02
10–11	82,458	187	2.27	4,299,863	52.15
11–12	82,271	180	2.19	4,217,498	51.26
12–13	82,091	182	2.22	4,135,317	50.37
13–14	81,909	193	2.36	4,053,317	49.49
14–15	81,716	210	2.57	3,971,505	48.60
15–16	81,506	232	2.84	3,889,894	47.73
16–17	81,274	256	3.16	3,808,504	46.86
17–18	81,018	285	3.52	3,727,358	46.01
18–19	80,733	315	3.89	3,646,483	45.17
19–20	80,418	344	4.28	3,565,907	44.34
20–21	80,074	375	4.68	3,485,661	43.53
21–22	79,699	398	5.00	3,405,774	42.73
22–23	79,301	412	5.19	3,326,274	41.94
23–24	78,889	418	5.29	3,247,179	41.16
24–25	78,471	425	5.42	3,168,499	40.38
25–26	78,046	432	5.54	3,090,240	39.60
26–27	77,614	440	5.67	3,012,410	38.81
27–28	77,174	451	5.85	2,935,016	38.03
28–29	76,723	465	6.06	2,858,067	37.25
29–30	76,258	479	6.28	2,781,576	36.48
30–31	75,779	493	6.51	2,705,557	35.70
31–32	75,286	511	6.78	2,630,025	34.93
32–33	74,775	530	7.09	2,554,995	34.17
33–34	74,245	550	7.40	2,480,485	33.41
34–35	73,695	568	7.72	2.406,515	32.66

TABLE 26—*Continued*

AGE INTERVAL (1)	NUMBER ALIVE AT BEGINNING OF AGE INTERVAL (2)	NUMBER DYING IN AGE INTERVAL (3)	MORTALITY RATE PER 1000 (4)	TOTAL POPULATION LIVING IN CURRENT AND HIGHER AGE INTERVAL (5)	COMPLETE EXPECTATION OF LIFE (6)
35–36	73,127	588	8.04	2,333,104	31.90
36–37	72,539	605	8.33	2,260,271	31.16
37–38	71,934	617	8.59	2,188,034	30.42
38–39	71,317	631	8.84	2,116,408	29.68
39–40	70,686	644	9.11	2,045,407	28.94
40–41	70,042	658	9.39	1,975,043	28.20
41–42	69,384	674	9.72	1,905,330	27.46
42–43	68,710	693	10.09	1,836,283	26.73
43–44	68,017	716	10.52	1,767,919	25.99
44–45	67,301	740	10.99	1,700,260	25.26
45–46	66,561	766	11.52	1,633,329	24.54
46–47	65,795	795	12.08	1,567,151	23.82
47–48	65,000	821	12.63	1,501,754	23.10
48–49	64,179	846	13.18	1,437,165	22.39
49–50	63,333	873	13.77	1,373,409	21.69
50–51	62,460	897	14.37	1,310,512	20.98
51–52	61,563	929	15.08	1,248,500	20.28
52–53	60,634	970	16.01	1,187,402	19.58
53–54	59,664	1,025	17.17	1,127,253	19.89
54–55	58,639	1,084	18.49	1,068,102	18.21
55–56	57,555	1,153	20.03	1,010,005	17.55
56–57	56,402	1,225	21.72	953,027	16.90
57–58	55,177	1,289	23.37	897,237	16.26
58–59	53,888	1,346	24.97	842,705	15.64
59–60	52,542	1,404	26.73	789,490	15.03
60–61	51,138	1,462	28.58	737,650	14.42
61–62	49,676	1,521	30.62	687,243	13.83
62–63	48,155	1,587	32.96	638,328	13.26
63–64	46,568	1,656	35.55	590,967	12.69
64–65	44,912	1,718	38.25	545,227	12.14
65–66	43,194	1,773	41.06	501,174	11.60
66–67	41,421	1,826	44.08	458,866	11.08
67–68	39,595	1,877	47.41	418,358	10.57
68–69	37,718	1,928	51.12	379,701	10.07
69–70	35,790	1,974	55.14	342,947	9.58

TABLE 26—*Concluded*

AGE INTERVAL (1)	NUMBER ALIVE AT BEGINNING OF AGE INTERVAL (2)	NUMBER DYING IN AGE INTERVAL (3)	MORTALITY RATE PER 1000 (4)	TOTAL POPULATION LIVING IN CURRENT AND HIGHER AGE INTERVAL (5)	COMPLETE EXPECTATION OF LIFE (6)
70–71	33,816	2,013	59.52	308,144	9.11
71–72	31,803	2,044	64.29	275,334	8.66
72–73	29,759	2,065	69.38	244,553	8.22
73–74	27,694	2,072	74.82	215,827	7.79
74–75	25,622	2,070	80.78	189,169	7.38
75–76	23,552	2,057	87.37	164,582	6.99
76–77	21,495	2,028	94.35	142,059	6.61
77–78	19,467	1,981	101.74	121,578	6.25
78–79	17,486	1,920	109.78	103,102	5.90
79–80	15,566	1,854	119.10	86,576	5.56
80–81	13,712	1,786	130.28	71,937	5.25
81–82	11,926	1,696	142.17	59,118	4.96
82–83	10,230	1,565	153.06	48,040	4.70
83–84	8,665	1,409	162.58	38,592	4.45
84–85	7,256	1,255	172.97	30,632	4.22
85–86	6,001	1,103	183.80	24,004	4.00
86–87	4,898	954	194.85	18,555	3.79
87–88	3,944	816	206.84	14,134	3.58
88–89	3,128	689	220.13	10,598	3.39
89–90	2,439	571	234.31	7,814	3.20
90–91	1,868	466	249.62	5,660	3.03
91–92	1,402	371	264.66	4,025	2.87
92–93	1,031	289	279.90	2,809	2.73
93–94	742	219	295.12	1,923	2.59
94–95	523	162	310.17	1,290	2.47
95–96	361	117	325.02	848	2.35
96–97	244	83	339.74	546	2.24
97–98	161	57	354.55	344	2.14
98–99	104	39	369.73	212	2.04
99–100	65	25	385.46	127	1.95
100–101	40	16	401.91	74	1.85
101–102	24	10	419.14	42	1.76
102–103	14	6	437.37	23	1.67
103–104	8	4	456.77	12	1.59
104–105	4	2	477.48	6	1.50
105–106	2	1	500.22	3	1.41
106–107	1	1	524.82	1	1.33

From such rates the life table is constructed. Such a life table (table 26) for the population of the original Registration States for the year 1910 was given by Dublin in the article quoted.

It is assumed that 100,000 individuals are born at a certain instant of time. During the first year of life, there was in this year a mortality rate of 114.6 per 1,000 births. Applying this rate to 100,000 births, there will be 11,462 deaths in the first year of life, and 88,538 survivors at the beginning of the second year. Similarly the application of the actual mortality rate to each succeeding number of survivors at each age, will give the number living at any age until all have died.

This operation results in showing that 40 will still be alive at age 100. Of these 40 individuals, 16 will die during the year. Twenty-four will therefore live one year. Assuming that the 16 who die, live on the average six months, these 16 will live a total of eight years. By following this process until at age of 106 years all have died, it will be seen that the 40 individuals of age 100 will live a total of 74 years. The fifth column shows the total number of years of life which the persons at any age will enjoy before all have died. From this column, it will be found that at birth the group of 100,000 people will have a life expectancy of 5,148,536 years, which is an average of 51.49 years for each one of them. This was the average expectation of life at birth in 1910. While this figure gives the individual no information as to his own length of life, it is an accurate estimate of the average length of life, and upon figures so obtained the amount of annual premium necessary to insure a life at any particular age is calculated.

The more lives are saved, the greater is the expectation of life. At present the death rates are falling, and will continue to fall with the progress of hygiene and sanitation, and the span of life will be proportionately increased. We may be certain that in our own time the average number of years of happy useful life will be considerably increased. But manifestly death rates cannot continue to fall beyond a certain limit, or the span of life be increased indefinitely, and we may well ask just how much

may be expected in this direction within a reasonable period of years. An answer to this question has been given by Dublin, based on the present state of our knowledge of preventive medicine, and present economic conditions.

POSSIBLE REDUCTIONS IN MORTALITY

The most important single item of mortality is that which occurs in the first year of life both because it is the largest, since 15 per cent of all deaths that occur each year are within the first year of age, and because a death at this time cuts off the entire expectation of life while death at a later age removes proportionally fewer years of life.

In the birth registration area of the United States, the number of deaths under one year of age per 1000 births dropped from 114.2 in 1910 to 75.6 in 1921. Great as this improvement is, this rate can be still further lowered. The rate for negro children included in the above rate in the same year was 110.7. In New Zealand in 1920, the infant mortality was below 50 per 1000 births, and there are many cities in the United States where the infant mortality is below 40 per 1000 births. Dublin therefore estimated that a rate of 38.2 is entirely realizable under present conditions within a relatively short period of years. It could probably be attained by a greater attention to the detection and treatment of syphilis in the mother, by a more extensive provision of good obstetrics, and of good milk and nursing for the child.

A similar reduction in mortality may be attained for the second to the fifth years of life. The mortality during this period is largely due to intestinal infections, measles, whooping cough, diphtheria, scarlet fever and other respiratory infections. All of these infections can be better controlled with no increase in present knowledge.

Between the ages of five and sixty, it is assumed that mortality can be reduced to one-half of the figure that prevailed in 1910. Such a great reduction appears improbable at first glance. But the attainment of such low death rates is merely a question of applying more generally the death rates that now obtain, or nearly so, in certain communities like New Zealand, and pre-

supposing that the preventable mortality from tuberculosis and other diseases will continue to decline as they have during the past few years.

It has been estimated that not more than 12 per cent of the rural population of the United States enjoy anything approaching modern health supervision. In 1924, 260 counties in 31 states were recorded as having full time health departments. There are 3065 counties in the United States. At present the health of 88 per cent of the population living on farms and in small towns

TABLE 27

Hypothetical life table

AGE	NUMBER LIVING IN SPECIFIED AGE INTERVAL	MORTALITY RATE PER 1000	EXPECTATION OF LIFE
0	100,000	38.21	64.75
1	96,179	10.00	66.30
2	95,218	4.20	65.97
3	94,818	2.80	65.24
4	94,552	2.25	64.42
5	94,339	1.85	63.57
10	93,648	1.14	59.02
20	92,269	2.34	49.82
30	89,772	3.26	41.06
40	86,318	4.70	32.49
50	81,542	7.19	24.08
60	73,882	14.29	16.01
70	56,213	56.45	9.17
80	22,818	130.28	5.29
90	3,110	249.62	3.03
100	67	401.91	1.85

is being impaired because of lack of proper health supervision, and their mortality rates compare very unfavorably with those obtaining in cities. Can there be any doubt that general mortality rates will again be greatly reduced if these rural dwellers should receive competent health supervision.

FURTHER PROLONGATION OF LIFE

The hypothetical life table constructed by Dublin and here presented (see table 27), expresses the greatest reduction in

mortality that may be expected with our present knowledge. It is again equivalent to a reduction of the total death rate (assuming no change in the age constitution of the population) to 8.6 per 1000, and an increase in the expectation of life at birth of 6.65 years more than the 58.10 years attained in 1924.

We may confidently expect further great additions to our knowledge concerning the cause and prevention of disease, and it is highly probable that economic conditions will continue to improve. Therefore we may reasonably expect an even greater prolongation of the average span of life than is indicated by this table. However, it should be pointed out that most of the saving of life has been during the earlier years. Raymond Pearl ("The Biology of Death") has constructed life tables for Europe during the seventeenth and eighteenth centuries and for the Egyptians two thousand years ago. For the early years, life expectation was far below that of the present time, but somewhere between the ages of sixty-five to seventy, the Egyptian line crosses the present American line, and from that period on, individuals living in Egypt at that time lived longer on the average than American of the present day. With the tremendous mortality of youth and middle age occurring in Egypt, only the strongest would survive to the age of sixty-five. The death rate of the earlier periods of life is selective, eliminating the weak and leaving the strong, and this suggests the possibility that the present increase in mortality from degenerative diseases is due to the saving of life in infancy and youth. It is quite impossible that we should give up the attempt to save infants and children. Nevertheless, we must recognize the possibility that if we go on saving weaker individuals at earlier ages, the rates for degenerative diseases in later life may continue to increase in spite of all efforts.

Pearl has also shown conclusively that longevity is hereditary. Among the figures which he presents is table 28 giving the average life of children according to the ages of their parents. That is, if both parents live to over eighty, life expectation of children is twenty years greater as compared with those whose parents die under sixty. Heredity determines the materials

of which the body is composed, or the strength of the parts of the machine, and is a fundamental determiner of the length of the span of life. The expectation of life, increased as the result of disease prevention, could be still further greatly extended by the selection of only one generation of ancestry for longevity.

This is quite beyond the scope of organized sanitary endeavor,

TABLE 28

Average life of children according to the ages of their parents

FATHER'S AGE AT DEATH	MOTHER'S AGE AT DEATH		
	Under 60	60–80	Over 80
Under 60	32.8	33.4	36.3
60–80	35.8	38.0	45.0
Over 80	42.3	45.5	52.7

TABLE 29

Death rate from tuberculosis in Massachusetts, England and Wales

YEAR	MASSACHUSETTS' RATES PER 100,000	ENGLAND AND WALES RATE PER 100,000
1851–1860	469.9	348.7
1861–1870	410.9	327.0
1871–1880	391.5	287.8
1881–1890	364.3	242.9
1891–1900	283.2	200.9
1901–1906	218.3	172.2
1910	163.0	143.0
1915	141.6	116.0
1920	113.8	102.0
1921	98 5	
1922	93 8	

but is a point deserving the thoughtful consideration of individuals.

So far, we have been discussing only general death rates. It will be interesting and useful to study the reduction that has been made in recent years for certain specific infections, and to consider the possibility that some at least of these infections can be reduced to the vanishing point.

TUBERCULOSIS

We may begin with tuberculosis which only a few years ago held the first place as a recorded cause of death. A remarkable decrease in this disease has occurred in all civilized countries, as examples of which we may quote the rates for Massachusetts and for England and Wales. In the latter country the death rate in 1924 for all forms of tuberculosis was 115.6 for males and 93.4 for females (see table 29.)

The death rate per 100,000 in the Registration Area of the United States for all forms of tuberculosis is as follows:

Year...	1880	1890	1900	1910	1915	1918	1919	1920	1921
Rate...	326.2	267.4	201.9	160.3	146.3	150.0	125.6	114.2	99.4

Year	1924	1925	1926	1927
Rate	90.6	87.0	87.1	80.8

In the United States by 1917 when tuberculosis was reduced to 147 per hundred thousand, the rate for heart disease was passing it. By 1924 tuberculosis had fallen from its evil eminence at the peak of human diseases to the fifth cause of death, being surpassed by the rates for heart disease, pneumonia, cerebral haemorrhage and cancer. The rate of 90.6 in 1924 is a 55 per cent decrease from 201.9 in 1900. A century ago, tuberculosis caused 1 out of every 3 or 4 deaths; a generation ago, it caused one-seventh of all deaths, but in 1924 it only caused 1 out of every 13 deaths.

There are several reasons for this remarkable improvement. There has been an organized campaign against tuberculosis. There are almost 700 sanitoria in the country, while there were scarce a score in 1900. These sanitoria care for 150,000 patients a year, and therefore withdraw from active life a large proportion of all people in the infectious stage. All these sources of infection are permanently removed from the general population, for the patients return either with sputum freed of bacilli, or trained in the proper care and disposal of this infectious material. The campaign against tuberculosis has accomplished many other reforms including better types of architecture, affording more air and light, and the improvement of the atmosphere breathed

by the miner, quarrymen, knife grinders, and other trades in which tuberculosis was an occupational disease.

But perhaps even more important than the organized campaign against tuberculosis has been the great general prosperity in recent years in the United States, which means better habitations, better food, and more rest and leisure. This may all be readily shown by official statistics. The estimated value of all property in 1904 was $107,000,000,000, whereas in 1912 it was $187,000,000,000. The per capita money in circulation was $13.85 in 1860; $19.45 in 1880; $22.82 in 1890; $26.93 in 1900; $34.33 in 1910; and $50.11 in 1920. Figures from the Department of Commerce and Labor indicate that there has been an actual increase in purchasing power. What cost $1.00 in 1914 now costs $1.70, but wages average $2.20 in 1924 to each $1.00 earned in 1914.

An increase in production means more goods to be distributed. The horse power per wage earner has increased from 2.75 in 1909 to 4.00 in 1925. That hours of labor have been shortened is shown by the fact that in 1909 only 8 per cent of all wage earners in factories were working eight hours or less per day, while in 1921, more than 51 per cent worked eight hours or less.

Bureau of Census figures show that in 1890, 37 per cent of all houses were owned, while in 1920, 41 per cent were owned, and the value of new construction in the year 1925 alone was equal to one-fifth of the actual expenditure of the United States in the World War.

Economic conditions have always tended to improve and there is no reason why we may not expect a continued increase in prosperity even though not at the rate enjoyed in the last few years.

The calamity howler is always with us. Macaulay (Southey's Colloquies) answered the pessimists of 1830 with such wisdom that his words are equally applicable today.

"The present moment is one of great distress. But how small will that distress appear when we think over the history of the last forty years; a war, compared with which all other wars sink into insignifi-

cance; taxation, such as the most heavily taxed people of former times could not have conceived; a debt larger than all the public debts that ever existed in the world added together; the food of the people studiously rendered dear; the currency imprudently debased, and imprudently restored. Yet is the country poorer than in 1790? We firmly believe that, in spite of all the misgovernment of her rulers, she has been almost constantly becoming richer and richer. Now and then there has been a stoppage, now and then a short retrogression; but as to the general tendency there can be no doubt. A single breaker may recede; but the tide is evidently coming in.

"To almost all men the state of things under which they have been used to live seems to be the necessary state of things Hence it is that, though in every age everybody knows that up to his own time progressive improvement has been taking place, nobody seems to reckon on any improvement during the next generation. We cannot absolutely prove that those are in error who tell us that society has reached a turning point, that we have seen our best days. But so said all who came before us, and with just as much apparent reason. 'A million a year will beggar us,' said the patriots of 1640. 'Two millions a year will grind the country to powder,' was the cry in 1660. 'Six millions a year, and a debt of fifty millions!' exclaimed Swift; 'the high allies have been the ruin of us.' 'A hundred and forty millions of debt!' said Junius; 'well may we say that we owe Lord Chatham more than we shall ever pay, if we owe him such a load as this.' 'Two hundred and forty-millions of debt!' cried all the statesmen of 1783 in chorus; 'what abilities, or what economy on the part of a minister, can save a country so burdened?' We know that if, since 1783, no fresh debt had been incurred, the increased resources of the country would have enabled us to defray that debt at which Pitt, Fox, and Burke stood aghast, nay, to defray it over and over again, and that with much lighter taxation than what we have actually borne. On what principle is it that when we see nothing but improvement behind us, we are to expect nothing but deterioration before us?"

Nevertheless, if the rates for tuberculosis are to continue to decline, there must be no decrease in the organized fight against that disease. Continued establishment of sanitoria is required until the ideal of a bed for every death for tuberculosis is attained. Should this occur, there will almost at once be more beds than deaths from tuberculosis. But such beds need not stand idle,

for if the time comes when there are more sanitoria than tubercular patients, such hospitals can be used for other diseases.

Should the rates for tuberculosis decline between 1925 and 1940 as they did between 1910 and 1925, the rate in 1940 would be 20 per 100,000 or about 25,000 deaths a year in the United States, and the conquest of tuberculosis will be at hand. The attainment of this goal will mean vastly harder work than that of the past decade.[3] That this goal is not impossible is shown by the Framingham Tuberculosis demonstration financed by the Metropolitan Life Insurance Company and conducted by the National Tuberculosis Association. At a cost of $200,000 in eleven years the death rate from the tuberculosis was reduced

TABLE 30

Typhoid death rate per 100,000 for England and Wales and Scotland

YEAR	ENGLAND AND WALES	SCOTLAND
1871–1880	32.2	39.0
1881–1890	19.8	23.0
1891–1900	17.4	18.0
1901–1905	11.0	11.0
1906–1910	7.0	
1924	1.3	

in Framingham from 121 per 100,000 prior to 1917 to 38 per 100,000 in 1923. This is less than half the rate obtaining at present in the Registration Area.

TYPHOID FEVER

The incidence and mortality of this disease is steadily decreasing at a rate that encourages us to believe that within a reasonable period it may be wholly eradicated (see table 30).

In the large cities of England and Wales with a total population of 19,474,270, the typhoid rate for 1926 was only 0.7, the rate for London being 0.6 and for Birmingham 0.45.

Typhoid was disgracefully prevalent in the United States a few decades ago, and although great progress has been made in

[3] Editorial, *American Review of Tuberculosis*, February, 1926, vol. 13, p. 183.

the control of this infection, its incidence is still high as compared with England and Wales.

The typhoid death rate per 100,000 population in the United States Registration Area is as follows:

Year	1890	1900	1910	1920	1924	1925	1926	1927
Rate	46.3	35.9	23.5	7.8	6.7	8.0	6.5	5.5

For large cities of the United States there have been three phases in the trend of the typhoid fever death rate during the past forty years. From about 1885 to 1895, the rates dropped from approximately 65 per 100,000 to about 30 per 100,000. This improvement was caused by the extensive sewering of cities, the elimination of privies and wells, and the wide extension of municipal water supplies. From about 1895 to 1905, there was little progress in typhoid fever control. It was still expected that hospitals would be filled with typhoid cases every summer, and it was in this period that the Spanish American War occurred with its typhoid infested camps. Between 1905 and 1910, the dates varying in different cities, filtration or disinfection of city water supplies was inaugurated. This improvement of city water supplies has been continuous. In the state of New York, 700,000 people were furnished with filtered or treated water in 1906. By 1926 the number had risen to 8,000,000. During this same period of twenty years the typhoid death rate dropped from 23.6 to 3.3 per 100,000. The greatly improved conditions of sewage disposal, water supplies and general personal cleanliness is also reflected in the great increase in the number of people employed in the plumbing trades. In 1870, there were in the United States only 209 plumbers, gas fitters and steam fitters for each 1,000,000 of the population, while there were 1956 such workmen per 1,000,000 in 1920.

In addition to eliminating sewage contamination from public water supplies, typhoid was further controlled during this period by pasteurization of milk, and the supervision of food in transit and in public markets. The great reduction in the number of cases of water borne typhoid has enabled public health authorities to concentrate their efforts upon the remaining cases which are

largely caused by the infection of food supplies by carriers. During 1926, 27 typhoid carriers were added to the list of known carriers in the state of New York. These carriers definitely caused 39 cases of typhoid and probably 12 others. Twenty-one cases of typhoid were infected by these carriers through milk. The active list of carriers in New York State now includes 137

TABLE 31

*Total average typhoid death rate (1910–1926)**

YEAR	TOTAL POPULATION (59 CITIES) ESTIMATED BY THE UNITED STATES CENSUS BUREAU METHODS	TYPHOID DEATHS	TYPHOID DEATH RATE PER 100,000
1910	21,125,340	4,143	19 61
1911	21,679,886	3,416	15 71
1912	22,234,865	2,800	12.59
1913	22,788,282	2,923	12.82
1914	23,342,199	2,443	10.46
1915	23,896,616	2,094	8.76
1916	24,368,470	1,874	7.69
1917	24,908,055	1,684	6.76
1918	25,142,605	1,583	6.30
1919	25,702,711	1,006	3.91
1920	26,340,793	934	3.54
1921	26,749,616	992	3.71
1922	27,133,857	862	3.18
1923	27,566,727	866	3.14
1924	28,174,489	870	3.09
1925	28,882,031	993	3.43
1926	29,620,891	822	2.77

* Typhoid in the large cities of the United States in 1926. Fifteenth Annual Report. *Journal of the American Medical Association*, April 9, 1927, vol. 88, pp. 1148–1150.

individuals exclusive of those who are inmates of state institutions.

Since 1910, the more general use of typhoid vaccination has had an important effect. During the World War 4,000,000 susceptible young men were vaccinated. If to these are added the large number of persons who have voluntarily received this treatment from city, county and state officials, and private practitioners, it will be seen that a considerable fraction of the

total population, possibly ten per cent have been thus protected. In 1906 the rate for 24 cities was 34.5 per 100,000 and this rate declined so rapidly that in 1923 it was reduced to 2.7 per 100,000.

This decline in the mortality from typhoid in our large cities is further shown by the table 31.

The typhoid death rate of cities in different parts of the country is shown in table 32. From this it will be seen that at the present time the rates for typhoid fever are still high in the cities of the Southern States. In the rural districts of these states the rates are even higher. In 1923 Tennessee had a typhoid fever death rate of 21, Georgia a rate of 20.5, Kentucky 19.3 and South Carolina 17.9, per 100,000. Florida, Louisiana, Mississippi,

TABLE 32

Typhoid death rates in the various geographic divisions in 1925

CITIES OF MORE THAN 100,000 POPULATION IN	POPULATION	TYPHOID DEATHS	RATE
New England States	2,308,266	56	2.42
Middle Atlantic States	11,279,063	333	2.95
South Atlantic States	1,354,748	110	8.12
East North Central States	7,344,968	163	2.22
East South Central States	570,012	92	16.14
West North Central States	2,072,228	64	3.09
West South Central States	717,491	103	14.36
Mountain and Pacific States	3,235,255	72	2.22

Colorado, Virginia, each have rates in excess of 10 per 100,000 of population. On the other hand there are a number of cities in the New England and Eastern states having rates below 2 per 100,000 and some in which typhoid has disappeared, and the rate is 0.

These facts lead inevitably to the conclusion that if the same measures that have so reduced the rates for typhoid in certain cities are more generally applied, particularly in the South and in rural districts, typhoid fever can be reduced to the vanishing point. It could then be eradicated once for all, if the entire population could be induced to submit to antityphoid inoculation every three years for a period of nine years. If the typhoid organism were thus rendered extinct in this country, typhoid could

be prevented from being reintroduced just as cholera is now kept out of the country. Such a consummation which seems highly improbable at the present time, may be well within the limits of possibility twenty-five or fifty years from now. At all events it is hoped that this possibility may encourage the more general use of antityphoid vaccine, and the general extension of the sanitary methods that have proven so successful in many cities.

DIPHTHERIA

Diphtheria formerly caused a very high mortality rate which has been greatly reduced in recent years. With no further in-

TABLE 33

*Number of cities with population over 100,000 with various diphtheria death rates per 100,000**

YEARS	RATE OF 40 AND OVER	RATE OF 20 AND OVER	RATE OF 10 AND OVER	RATE OF UNDER 10
1890–1894	50	50	52	2
1895–1899	33	49	56	0
1900–1904	18	43	55	1
1905–1909	2	36	55	3
1910–1914	1	34	53	13
1915–1919	0	22	52	18
1920–1924	0	13	52	18
1925	0	4	28	49

* Article on diphtheria in large American cities, *Journal of the American Medical Association*, April 3, 1926, vol. 86, p. 1005.

crease in knowledge diphtheria could also be reduced to the vanishing point, if certain methods now used in a few cities could be generally applied.

The death rate in England and Wales for diphtheria declined from 26 per 100,000 in the years 1891–1900 to 6 per 100,000 in 1924, a decrease of 77 per cent.

In New York City proper, the deaths from diphtheria for the ten year period 1878–1887 averaged 168.4 per 100,000. The general administration of antitoxin began in 1894, with the result that by 1911 the mortality for diphtheria in the old city of New York was reduced to 28 per 100,000.

The general decline in diphtheria death rates is shown by table 33 and table 34. The decline in deaths from diphtheria per 100,000 in the United States Registration Area is as follows:

Year	1890	1900	1910	1920	1923	1924	1925	1926	1927
Rate	70.1	43.3	21.4	15.3	12.1	9.4	7.8	7.5	7.8

These figures up to the year 1920 represent the improvement in mortality from the more general and earlier use of antitoxin. Antitoxin treatment has reduced the mortality from diphtheria from above 40 per cent of all cases to below 10 per cent, and some further improvement in the mortality from diphtheria may still be achieved by earlier diagnosis and treatment of all cases.

But it is evident that this is treatment of the disease after it has occurred, which does not affect the incidence of the disease.

TABLE 34

Total average diphtheria death rate

YEAR	TOTAL POPULATION 70 CITIES	RATE PER 100,000
1923	29,243,128	13.12
1924	29,810,998	11.05
1925	31,049,595	9.74

During all these years, sanitary authorities have been attempting to reduce the incidence of diphtheria by quarantine of cases, and identification and control of carriers. These measures have not given the results that were hoped for and expected, and between 1910–1920 there was comparatively little improvement in the incidence of diphtheria. In the spread of a contact disease like diphtheria two factors are essential; cases or carriers of virulent organisms, and susceptible contacts. The control of carriers has been only partially successful, but a decrease in the number of susceptible persons will also definitely decrease the transmission of the disease. Since 1920 a new impetus has been given to the control of diphtheria by the discovery that children could be immunized against diphtheria by several injections of a mixture of diphtheria toxin and antitoxin. About 70 per cent of the deaths from diphtheria occur in children under five years

of age. The process of immunization causes almost no reaction in children, so that the obvious measure to eliminate diphtheria would be the general immunization of all young children, and the use of this method is being rapidly extended. In 1921, a survey made of cities of 100,000 population or over indicated that but 3 per cent of these larger cities were administering toxin antitoxin immunization. A second survey made in 1924 of cities having 70,000 population or over, showed that practically all of these cities were organized for the administration of this preventive of diphtheria.

There are now several cities where the incidence of diphtheria has been cut 60 per cent or more in three years by the use of this method. The district health officer reported the results of the endeavor to eliminate diphtheria in the city of Auburn, New York, a city of about 37,000. There had been 48 deaths from diphtheria per 100,000 during 1920–1921. During 1922, 58 per cent of school children were given the Schick test and immunized when necessary. From March, 1922, to March, 1923, 78 cases of diphtheria occurred with 13 deaths. This led to further immunization up to 73 per cent, and during the following year only 15 cases developed and four died. By 1924, 85 per cent of the school children and a large proportion of the preschool children had been immunized. The last death from diphtheria in that city up to the date of the report, occurred on July 31, 1923. (Sears, *American Journal of Diseases of Children,* November, 1926.) Certain states and cities are planning to eradicate the disease in the next five years. Should they succeed in this endeavor, there is no reason why the method should not be universally used, with the result that diphtheria could be eradicated in the United States in the course of the next twenty-five years.

MEASLES

The incidence of this disease is not yet fully controlled by sanitation, nevertheless for the seventeen years following 1885 the measles death rate in 22 American cities fell at a rate of nearly six per cent a year. In 1887 the measles death rate for

these cities was 35.9 per 100,000 while in 1921 the rate was 3.8 per 100,000.

The death rate for measles in the United States Registration Area was:

Year	1890	1900	1910	1920	1924	1925	1926	1927
Rate	13.5	13.2	11.6	8.8	8.6	2.3	8.2	4.1

The disease was naturally more prevalent in large cities than in smaller communities where young children are less apt to be exposed. Nevertheless during this period the reduction in mortality is more striking in the large cities than in the whole Registration Area. This may be due to the better treatment received in cities.

Since the number of cases of measles has not been proportionately reduced, this general decline of the death rate is probably due to the protection of young children and the delayed onset of the disease so that it occurs at an age when the mortality is practically nil. Only recently, some authorities believed that nothing further could be done along this line and that without further discoveries, a rate of 5 per 100,000 is about the best that may be expected for the future. The great reduction in the mortality from measles in the Registration Area of the United States during 1925, when the rate per 100,000 actually fell to 2.3 shows that this view is altogether too gloomy. Moreover there have been new discoveries. It has been found that the injection of serum from recent convalescents will prevent the disease in children that have been exposed to measles, provided that this treatment is given sufficiently early, and when given too late to afford complete protection, the disease that develops is very mild and devoid of danger to life. Even the blood serum of adults who had measles in childhood may be used to modify the disease in children so that it will take only a mild form, and yet, will give immunity for life just as the severe form of the disease does. There is also some reason to believe that the organism causing measles has been finally discovered and an antitoxic serum produced. If this announcement made in 1925 is substantiated we may expect a still further and considerable reduc-

tion in the mortality from measles as the result of a general introduction of antitoxin treatment.

SCARLET FEVER

Scarlet fever is a disease which is not greatly reduced in prevalence, but whose mortality has been greatly reduced. It has always been believed that scarlet fever is much more dangerous than measles. This may have been the case formerly, but if it was ever true, then the virulence of scarlet fever has been greatly reduced in recent years. In the *British Medical Journal* of October 23, 1926, it is stated that in London, of every 1,000,000 people living during the past fifteen years 251 have died annually from measles, but only 42 from scarlet fever. The case mortality from measles was 10.6 per cent while that from scarlet fever was only 1.5 per cent.

TABLE 35

Death rates from scarlet fever in Great Britain

	1861–1870	1871–1880	1881–1890	1891–1900
England and Wales	89.0	64.9	31.2	15.6
Scotland	91.0	78.0	29.0	19.0

The rates given by McVail for Great Britain, being the deaths per hundred thousand of all living, are shown in table 35.

The death rates for scarlet fever in the city of Chicago, per 100,000 are as follows:

Decade	1867–1876	1877–1886	1887–1896	1897–1906	1907–1916
Rate	80.0	63.5	21.1	14.2	19.6

Decade	1917–1922
Rate	7.9

The death rate for scarlet fever in the Registration Area was:

Year	1890	1900	1910	1920	1924	1925	1926	1927
Rate	13.6	11.6	10.2	4.6	3.1	2.7	2.5	2.3

With the development of antitoxic serum for the treatment of this disease, it is probable that in the next decade there will be a

further reduction in the mortality. One writer found that a case mortality of 3.25 per cent in 1924 was reduced to 1.2 per cent in 1925 by the use of this antitoxin, and states that he has not seen a case of scarlet fever die if serum treatment was given within two days of the onset of the disease. The number of complications such as middle ear disease and nephritis was also greatly reduced. Here then is a disease that cannot be eradicated without further improvement in methods of sanitary control, but whose mortality can be reduced to practically zero.

WHOOPING COUGH

The mortality from whooping cough in twenty-three American cities has dropped from 24 per 100,000 in 1885 to 5 per 100,000

TABLE 36

Decline in mortality from specified communicable diseases, 1885 to 1923, in a group of American cities

DISEASE	CHANGE PER YEAR IN UNITS OF DEATH RATE PER 100,000	CHANGE PER YEAR AS PER CENT OF MEAN RATE FOR 1885–1923
Diphtheria	−2.8	−5.1
Scarlet fever	−0.79	−5.1
Measles	−0.43	−2.9
Whooping cough:		
1885–1915	−0.55	−4.1
1885–1923	−0.49	−4.0
1915–1923	−0.29	−3.8

in 1923, a yearly reduction of about half a point per 100,000 over the entire period.

The rate of decline however has not been uniform, but was more rapid during the earlier years.

The number of deaths from whooping cough per 100,000 for the city of Chicago is as follows:

Years	1867–1876	1877–1886	1887–1896	1897–1906	1907–1916	1917–1922	1926	1927
Rate	30.9	19.7	15.0	12.0	6.2	5.8	8.9	6.9

The death rate for whooping cough in the Registration Area was 15.8 in 1890, 12.1 in 1900, 11.4 in 1910, 12.5 in 1920, 8.3 in 1924 and 6.7 in 1925, showing that this is another disease which is now better controlled in large cities than in the country as a whole, where there is room for great improvement through the more general adoption of measures applied in the large cities. School inspection and the isolation of active cases at an early stage are probably responsible for the good results in cities.

The decline in mortality from the children's diseases in a group of twenty-three American cities from 1885 to 1923 is shown in table 36 published by the Metropolitan Life Assurance Company.

All of these four principal diseases of childhood, diphtheria, measles, scarlet fever and whooping cough have a tendency to recur in epidemic form about every seven years. During 1926, the mortality from measles and whooping cough was unusually high. But while these epidemic years cannot be avoided until the diseases are entirely controlled, these periodic waves or peaks are growing lower with the generally decreasing rate. It is a hopeful sign that the rates for diphtheria and scarlet fever were low in 1926.

DECREASE IN INFANT MORTALITY

There has been a phenomenal decrease in the number of deaths of children under five years of age during the past two or three decades. In England and Wales, a rate of 150 per 1,000 population in 1891 was reduced to 75 in 1925, and to 70 in 1926. In 1900 in the United States Registration Area, 17 per cent, or one in six of all infants died before reaching their second birthday. In 1922, eight per cent or less than half as many died during the same period. In 1900, 2.1 per cent died each year between the ages of one year and five years. In 1922, 0.7 per cent, or one-third as many died in the same age group.

This reduction in child mortality may also be shown by taking the figures from one of our large cities. In Chicago the mortality of children per 1000 of total population has been as shown in table 37.

A large part of this reduction is owing to the decrease in the

children's diseases that have already been considered, but there has also been a remarkable decrease in mortality from other conditions.

One of the heaviest items in the mortality of young children is diarrhoea, and other intestinal disorders caused by improper feeding. Most of the intestinal disorders of children can be prevented by cleanliness and proper feeding, and knowledge concerning the care of children has been rapidly diffused during the past two decades, at the same time that pasteurization of milk supplies has become general. In 1900, in twenty-three American cities, the death rate for diarrhoea and enteritis in children under five years of age was 154 per 100,000 population, while in 1924 this rate was reduced to 29 per 100,000.

TABLE 37

Mortality of children per 1000 of total population in Chicago

DATE	UNDER ONE YEAR RATE	FROM ONE TO FOUR YEARS RATE
1868–1876	8.40	4.71
1877–1886	6.32	4.17
1887–1896	5.80	3.25
1897–1906	3.12	1.58
1907–1916	2.94	1.34
1922	1.71	0.69

The rate per 100,000 for diarrhoea and enteritis under two years of age in the Registration Area was 108.8 in 1900; 100.8 in 1910, which was reduced to 44.0 in 1920, 31.5 in 1925, 27.0 in 1926, and 21.6 in 1927. These figures indicate that the chances for infant survival are now better in large cities than in small towns and rural communities, since the mortality rate has not been reduced in the registration area to the same extent as in the large cities where pasteurization of milk is enforced. Undoubtedly the rate in the registration area can be still further reduced.

MALARIA

Some authorities have claimed that malaria is the most important of human diseases. For although it is not a very fatal

disease, it is constantly present in practically all tropical regions, and many temperate regions, so that in all probability, at any one time, more people suffer from malaria than from any other single disease. In India alone it has been estimated that it causes an average annual death rate of 5 per 1000, which means that every year about 1,130,000 persons in India die of malaria.

Such deaths are the least part of the damage caused by malaria, for as the disease seldom kills, such a mortality means that nearly the entire population of such tropical countries suffer from malaria, and it has been estimated that from a quarter to a half of all sickness in such regions is so caused. No place that is heavily infected with malaria can be very prosperous, and it has been more than suggested that the introduction of malaria was the chief cause for the downfall of the "glory that was Greece and the grandeur that was Rome."

Other diseases such as cholera, plague and influenza come and go, but when malaria once invades a locality, it remains permanently. It is eradicated with difficulty even by an organized sanitary campaign, because the people who are infected remain carriers over long periods of time.

Malaria exists in most parts of the United States, but as would be expected, its heaviest incidence is in low lying areas along the Atlantic Coast and in certain Southern States.

During the past twenty years an increasing amount of effort has been expended by sanitary organizations in the United States in the control of malaria, and excellent results have been obtained. The mortality caused by malaria in the registration area was 19.2 per 100,000 in 1890; 7.9 in 1900; 2.2 in 1910, 3.6 in 1920, 2.5 in 1924, 2.1 in 1925, 1.9 in 1926, and 2.7 in 1927, a very satisfactory reduction: There are still some badly infected areas, since in many parts of the registration area there is no malaria at all. In 1911 a group of 51 cities in the South and Southwest had a malaria death rate of 14.1 per 100,000. This was reduced to 3.5 in 1920, as shown in table 38.

The future of malarial control work in the United States is difficult to prophesy. Eradication is very difficult, and the reduction of malaria rates over any length of time means that

each year an organized effort must be made, over a long period of years. If this work is continued, the time will come when infected human carriers will become increasingly rare, and with the simultaneous reduction of anopheles, malaria will cease to spread. When that time comes, it is possible that the disease may be eradicated over large areas that are now infected more or less heavily. But such yearly campaigns require money, and the chief difficulty is to secure adequate funds for prosecuting such

TABLE 38

Reduction of death rate from malaria

DATE	RATE	DATE	RATE
1911	14.1	1916	5.5
1912	13.1	1917	6.0
1913	10.0	1918	5.2
1914	8.4	1919	5.3
1915	8.7	1920	3.5

TABLE 39

Death rate per 100,000 from infectious diseases in the United States Registration Area

	1890	1900	1910	1920	1925
Erysipelas	5.4	5.1	4.5	3.1	2.4
Meningococcus meningitis		5.8	0.4	1.6	1.1
Rheumatism		9.5	7.5	4.9	4.0
Bronchitis	74.4	45.7	23.4	13.3	6.5
Septicaemia		8.4	3.5	1.4	

work. There are pretty definite data on hand indicating the cost of antimalarial work. In heavily infected communities, malaria can be reduced to a very small minimum at a per capita cost of from 45 cents to $1.00 a year. After adequate control has once been established, it can be maintained from year to year at a much lower cost.

The International Health Board of the Rockefeller Foundation has selected malaria as one of the diseases to fight in its campaign for better health. In 1925 this board gave assistance in malarial control to twelve of the United States as well as to Porto Rico,

Brazil, Argentine, Italy, Palestine, and the Philippine Islands. With this great organization to maintain the interest and furnish part of the funds, the prospect for the control of malaria in the United States and other countries is greatly improved.

There are a number of other infectious diseases whose incidence and mortality are being gradually reduced, and although the results do not appear striking in individual instances, the sum total of such reductions is considerable.

The death rate per 100,000 in the Registration Area for some of these diseases is as shown in table 39. In the case of cerebrospinal meningitis, a reduction was to be expected because of the increase in knowledge of the method of transmission during the past twenty years, as well as the more general use of antimeningococcus serum which has reduced the mortality from this disease from about 80 per cent to approximately 30 per cent. The decrease in the amount of acute articular rheumatism has undoubtedly followed the more general removal of infected foci such as diseased tonsils and infected teeth. The reduction in bronchitis is more considerable and is not so readily explainable. It is probably due to a combination of factors including improved general hygiene, and better treatment, and improved diagnosis. Few die of uncomplicated bronchitis. Many cases that were formerly called bronchitis were undoubtedly tuberculosis. If this explanation is correct, and these cases are now being classified under tuberculosis, it makes the decline in the mortality from that disease even more striking.

SYPHILIS

As great an authority as Osler has placed syphilis at the head of the killing diseases, causing as it does a large proportion of infant mortality and of deaths from heart disease, apoplexy and arterial disease, but the deaths attributed directly to syphilis form a very inconspicuous item in mortality statistics. Even when deaths from locomotor ataxia, and general paralysis of the insane, (two conditions that are known to be the result of syphilis of the nervous system) are included, the total is still but a small portion of the deaths caused by syphilis.

Syphilis is undoubtedly one of the most important causes of death, and any decrease in the mortality from syphilis during the past twenty years would help materially to explain the increase in the span of life over that period. No such decrease can be shown by official statistics. Indeed these figures show rather an increase in the number of such deaths. This is shown by table 40 which gives figures for the United States Registration Area. There are the best of reasons for believing that this increase is not real, but is caused by better reporting of deaths caused by syphilis. The general use of the Wassermann reaction which was unknown in 1900 would alone account for most of this in-

TABLE 40

*Death rates from syphilis in United States. Registration Area, 1900 and 1920**

	1900		1920	
	Deaths	Rate per 100,000	Deaths	Rate per 100,000
Syphilis	1,029	3.3	7,969	9.1
Locomotor ataxia	593	1.9	1,611	1.8
General paralysis of the insane	1,955	6.3	5,030	5.7
Total	3,577	11.6	14,610	16.7

* Mortality Statistics, 1920, Bureau of Census.

crease, and practically all of our present scientific knowledge of syphilis dates from 1905, when the causal organism was discovered.

On the contrary, in spite of these figures, there is excellent reason for believing that both the incidence of syphilis and the number of deaths caused by it have been greatly reduced during the past ten or fifteen years, and that still further great reductions are in sight. In 1900 *Treponema pallidum* romped about the country practically without let or hindrance. Since that time the national government through the Public Health Service, as well as practically all cities and states have adopted measures that distinctly limit the circulation of this organism. In 1900, practically every large city had its red light district, while at the

present time very few cities officially recognize this traffic. More especially there has been a great advance in the matter of treatment. In 1900, only a few reputable physicians desired such patients, and many were treated by advertising quacks. Today, nearly all physicians treat such cases, the number of real specialists has greatly increased and the number of advertising quacks is greatly decreased. Ten years ago there were only fifty clinics in the United States for the treatment of venereal

TABLE 41

Admission rate per 1000 for syphilis in the United States Army, both white and colored, in the United States proper (excluding foreign service)

YEAR	RATE	YEAR	RATE
1900	19.62	1914	18.53
1901	19.35	1915	17.24
1902	23.03	1916	18.36
1903	23.64	1917	15.17
1904	28.47	1918†	27.95
1905	30.02	1919	21.36
1906	27.28	1920	12.28
1907	25.36	1921	10.74
1908	23.15	1922	13.33
1909	26.85	1923	13.76
1910*	26.65	1924	13.80
1911	44.30	1925	11.19
1912	25.58	1926	11.91
1913	20.99	1927	10.72

* Wassermann test and salvarsan.

† War year.

diseases. In 1926, there were 850. Wassermann reactions are made at the request of any physician at the public health laboratories of nearly all cities and states. Treatment with arsphenamine (salvarsan) combined with mercury is almost universal, and each patient properly treated not only has probably had several years added to his own life, but he ceases to be a source of infection to others. Under these circumstances it is inconceivable that there are either as many infections or as many deaths today as were caused by syphilis twenty years ago.

We have no really accurate knowledge of the incidence of

syphilis in the general population either twenty years ago or today, nevertheless, there is some information pointing toward the lesser incidence of syphilis today. In 1914, recruits for the Army showed between 8 and 9 per cent of completely positive Wassermann reactions. At the present time the percentage is less than three in the same class of men.

Better evidence may be obtained by studying the incidence of syphilis in a comparatively small body of men where the diagnosis has been accurate and statistics carefully kept. Such records may be obtained from the admission rates for syphilis in the Army in the United States, at present a body of approximately 100,000 men, which are as given in table 41. These figures show that the rate for syphilis remained high from 1900 to 1910. During 1910 the Wassermann test began to be used in the Army as a diagnostic measure, and this as well as the hope of obtaining treatment with salvarsan led to a great increase in admissions during the year 1911. Following that year, however, there has been a consistent decrease in the admissions for syphilis, only interrupted by the War years 1918–1919, when many recruits suffering from syphilis were accepted, who would have been rejected in peace time.

There is every reason to suppose that a similar condition exists in civil life, and that there has been a great reduction in the number of new syphilitic cases since 1910 when treatment with salvarsan was introduced. There is further no reason to suppose that we have reached the end of this improvement. Special effort is being made and must be continued to educate people to report for diagnosis and treatment if necessary, as soon as any suspicion of syphilitic infection arises. The continued establishment of public health clinics is likewise necessary to make diagnosis and treatment readily available for those who cannot afford the service of a physician. To the extent that this effort is successful the disease will be controlled and its incidence decreased.

Improved rates may be expected for many other infectious diseases that cannot be itemized. There were 33 deaths from rabies in man reported from eighteen cities in 1925. In addition

to the Pasteur treatment, it is possible that in the near future, vaccination of pet dogs for rabies will be widely extended if not made compulsory. Over 100,000 dogs have been vaccinated in Japan between 1919–1924, and of these only 41 developed rabies, while among one-third as many unvaccinated dogs, there were 16,991 cases of rabies during the same period. A study of the efficiency of canine vaccinations is now being made by federal and certain state and city laboratories. Rabies is a disease that can be eradicated when proper measures are enforced. It has already been eradicated in Great Britain, Australia, New Zealand and Norway and Sweden.

The facts presented demonstrate that great progress has been made in the control of disease during recent years, and that many diseases could be completely eradicated if our present information could be more universally applied. The results attained in the prevention of infectious diseases attract the most attention at the present time, but equally good results have been obtained in the prevention of nutritional diseases such as scurvy, beriberi, rickets and pellagra. There has been a recent flood of information concerning the diseases caused by alterations in internal secretions. If these diseases cannot be prevented, the mortality caused by them has been greatly reduced, and may be still further reduced. And even in the case of degenerative diseases, although their mortality rates are now increasing, this may only be because there are now more people living to the age at which such diseases occur, and does not by any means indicate that these diseases are not at least partially controlled. The further control of the degenerative diseases and particularly cancer depends upon individual effort and improved personal hygiene rather than upon the organized sanitary services.

Ponce de Leon sought the fountain of eternal youth and failed, for he was searching for the impossible and unattainable. But scientific medicine, in discovering the causes of disease and facilitating its prevention has at least realized a part of the universal desire for the prolongation of life, and the conquest of disease is now a practicable ideal.

REFERENCES

(1) Whipple: Vital Statistics, 1923.
(2) Mulhall: Dictionary of Statistics, 4th ed.
(3) Mortality Summary of 76 Large Cities. *Public Health Reports*, January 25, 40: 162.
(4) Statistical Abstract of the United States. Department of Commerce, 1922.
(5) Dublin: The Possibility of Extending Human Life. Harvey Lecture, December 1, 1922. Published by the Metropolitan Life Insurance Company.
(6) Tuberculosis in the United States. Department of Commerce and Labor, 1908.

CHAPTER VII

The Cancer Problem

The incidence of the infectious diseases is greatest during the first third of life. One who has reached forty years of age has successfully run the gauntlet of the infectious diseases, and has acquired immunity to many of them. At this period, which should be the golden age of life and when a man's value to his family and to the community is at its highest, the incidence of cancer becomes more marked; and liability to contract it increases with each succeeding decade. Statistics from England indicate that of those living in that country at the age of thirty-five, 1 man in 11, and 1 woman in 8, will die of cancer. The figures in this country are very similar.

Cancer is no new disease. It was mentioned in the Ebers Papyrus (B.C. 1500), and in the oldest writings of India, and was treated by the ancients by excision (surgical removal) and by caustic pastes. An arsenical ointment was used by the Egyptians, and is still used today by quacks who claim to cure cancer "without the knife."[1]

A disease having the characteristics of cancer, that has been known since the dawn of medicine, has naturally attracted a great deal of interest. Alarmed by the increasing death rate from cancer, numerous cancer research laboratories have been founded during the past twenty years at an expense of millions of dollars, and many investigators are now attacking the subject

[1] A cancer as well as normal tissue may be destroyed by such caustics, and an occasional cure may have been accomplished by this method. But the application of caustic must be long continued, is very painful and its effect most uncertain. During the time consumed in this treatment, the cancer has time to be carried to other portions of the body. No reputable practitioner would recommend this method today for any operable cancer in preference to the rapid, painless and more certain result of modern surgery.

from all the various angles, so that an enormous literature on cancer has accumulated.[2]

But in spite of all this effort, although a great deal is known about cancer, we are still obliged to call cancer a problem and to admit that as yet we have no conclusive answer to most of the questions concerning this disease that naturally suggest themselves. Is the incidence of cancer increasing? What is the cause of cancer? Is it possible to prevent the disease, and what measures must we take to reduce the mortality from cancer? Before attempting to answer these questions, it will be well to define cancer.

The majority of students employ the English word cancer to mean any malignant tumor, of which there are two types: *Carcinoma*, the malignant epithelial tumor, and *sarcoma* the malignant connective-tissue tumor.

Tumors are spontaneous new growths of tissue resembling but not identical with the normal tissue from which they originate.

[2] The director of the American Society for the Control of Cancer notes that the following research institutions, among others, are adding to the scientific knowledge as to the cause, prevention and cure of cancer: Institute of Cancer Research of Columbia University; the State Institute for the Study of Malignant Disease at Buffalo; the Cancer Commission of Harvard University; the Imperial Cancer Research Fund of England, and hospital and research organizations such as the Collis P. Huntington Memorial Hospital, Boston; the Memorial Hospital, the New York Skin and Cancer Hospital, and the New York City Cancer Institute, in New York City; the Barnard Free Skin and Cancer Hospital, St. Louis; the Albert Steiner Ward for Cancer and Allied Diseases, Atlanta; the George Chase Christian Hospital and Clinic, University of Minnesota, Minneapolis; the American Oncologic Hospital, Philadelphia; the Pennsylvania Cancer Commission; the Middlesex Hospital in England, and others. In addition, there is the American Association for Cancer Research, established in 1907, with a membership of 148, whose researches are published in the *Journal of Cancer Research*, and the American Society for the Control of Cancer, established twelve years ago, to carry on a campaign of education as a means of using the existing knowledge of cancer to the fullest extent; about 25,000 volunteer workers engage during the year in this educational work of instructing the public by lectures, newspapers, radio and other means of publicity. The Society's headquarters are at 370 Seventh Avenue, New York, where inquiries on all aspects of cancer will be answered. The Surgical Pathological Laboratory of the Johns Hopkins Hospital has a special fund for cancer research especially with regard to the ultimate results of treatment.

The gross structure of normal tissues and organs is very constant, and the individual cells of each organ have a very definite form and arrangement. In tumors, on the other hand, there is no constant anatomical structure, and we find cells that are abnormal in form, in relation to other cells and in function. A normal gland such as the liver or pancreas has cells grouped so as to form tubules or retort-shaped structures called acini, and the secretion from these cells is usually carried away by a duct. Tumors of such a gland do not follow this normal form, have no duct, and produce no secretion. In short, they are useless. But tumors are well supplied with blood vessels and derive their nourishment at the expense of the rest of the body. They may therefore be regarded as parasites that sap the strength of the host.

The most serious feature of a tumor is that its capacity for growth is unlimited. The laws governing the growth of normal tissues and organs are very rigid and no normal organ continues to grow beyond the point at which it is useful. A normal liver or pancreas grows to the point where its function fulfills the needs of the body for that particular organ and then stops growing. If some of the cells of such a normal organ are destroyed by disease or removed by an operation, more cells may sometimes be formed to restore the part destroyed, and when this is accomplished, growth again stops. There is some system of checks and balances which keeps each organ and tissue in its proper place in the bodily economy. But tumor tissue has escaped from such laws that govern the rest of the body, is not subject to any control, and there is no limit to its growth. Tumor cells are ordinary tissue cells which have become lawless and abide by none of the rules, but live at the expense of other cells of the body, and are endowed with an endless capacity for growth and multiplication. Tumors will continue to grow even during starvation when the rest of the body is wasting away. Tumor cells in their relation to the body may be compared to an organized band of criminals which preys upon society and constantly increases in numbers until the society is destroyed.

Although all tumors have this lawless character, some are more

lawless than others just as in society we have various grades of criminals, sneak thieves, burglars and murderers. Certain tumors are distinctly localized, may grow slowly, and may even have a surrounding capsule, and grow expansively. While such tumors are as truly parasitic as any others, they only cause injury by sapping the vitality or by crowding normal tissues out of the way. They rarely cause death, and then only when they press upon some vital organ like the brain or from some accident such as ulceration and haemorrhage. If they are removed by surgical operation they do not recur because they are so localized that they may be completely removed. Such tumors are called *benign*. On the other hand, there are tumors possessed of such an enormous power of growth that they do not remain localized, but the tumor cells burst through all surrounding tissues and into the blood vessels and lymph channels. Such tumor cells are carried by the circulation to other parts of the body, and wherever they lodge, they continue to grow and thus form secondary tumors. This process is called *metastasis* and such tumors are *malignant*.[3] *Malignancy* includes the qualities of rapidity of growth, infiltrative growth, and the formation of metastases. Tumor cells are especially apt to be deposited in any organ like the liver or the lungs where the blood supply branches out into innumerable capillaries and the force of the blood stream is diminished. The liver and lungs are perhaps the commonest sites of such secondary tumors, although they may be found in any part of the body, and the secondary tumors so formed may be many times the bulk of the original tumor. Such a tumor cannot be cured by cutting it out, burning it out, or by any other means, *unless it is identified and removed at a very early stage* before tumor cells have been carried to other parts of the body. After secondary tumors have been planted all over the

[3] The most characteristic feature of malignity is the ability of the malignant cell to produce new tumors when the cell wanders from the original local growth (infiltration) or is carried by the lymph or blood stream to some distant part (metastasis). Normal cells do not do this. After a fracture, fat cells may be carried to the lung but they do not produce a tumor. In inflammation, leucocytes and other inflammatory cells may wander, but these cells die as soon as the inflammatory reaction subsides. (Bloodgood.)

body including such vital organs as the liver and lungs, it is incurable, and sooner or later, generally sooner, it causes death.

Cancers are precisely this sort of malignant tumor. Among cancers there are all grades of malignity, and benign tumors may and often do undergo some change and become malignant.

The blood vessel supply of tumors is usually far in excess of that to normal tissues. If for any reason, such as injury, mechanical pressure or torsion this blood supply is reduced, the portion of the tumor so cut off from nourishment dies, and is sloughed off leaving an ulcer, which subsequently becomes infected by bacteria and produces an evil smelling discharge and constitutional symptoms of intoxication. This is a late stage, occurring usually only when the tumor, if cancer, is inoperable. Such ulceration is the final stage of most cancers of the skin and mucous membranes, and death from cancer is consequently one of the most unpleasant of all methods of shuffling off this mortal coil. It cannot be too strongly emphasized that pain, discharge and bleeding are generally late symptoms of cancer, occurring after metastases have formed and the condition is inoperable.

Although tumor cells differ in many ways from normal cells, and no tumor is precisely like the tissue from which it originates, yet there are many resemblances. A tumor originating in bone will have many of the characteristics of bone, and one arising from a gland will have an abnormal glandular structure. The tissue from which a tumor originated can thus be determined by microscopic examination. Since these tumors have been carefully studied microscopically for many years, and their structure compared in each case with the rate of growth of the tumor and the ultimate history of the patient, pathologists are now able by a microscopic examination of the tumor to tell from whence it originated, whether it is benign or malignant, and the prospect for recovery or death of the patient.

Based on this structure, pathologists have given names to all kinds of tumors which seem complicated to the layman. This terminology is much like a cipher or code, which is unintelligible without the key. But the key to this terminology is very simple. A tumor is named from the histological structure from which it

originates. There are three main types of tissues, (1) connective tissue, including bone, cartilage, fibrous tissue and fat, and (2) the external epithelial structures, including the external skin and mucous membranes, (3) the epithelial lining of the intestinal and genito-urinary tracts, and the glands derived from these epithelial layers.

When the embryo commences its development, it consists of three layers, known as epiderm, mesoderm, and hypoderm. The skin and mucous membranes develop from the epiderm. The connective tissues develop from the mesoderm, and the epithelium of the intestinal tract and the glands developing from it are derived from the hypoderm. The lungs, liver, pancreas and other structures are derived in the process of embryologic development as offshoots from the intestinal epithelium and the glandular structure is formed from this epithelium with a supporting framework of connective tissue. Similarly the kidneys, uterus, and ovaries are derived from the epithelium of the genito-urinary tract.

Tumors are seldom strictly epithelial or glandular, but all have more or less connective tissue framework, just as do normal glandular structures. Nevertheless, it is easy to classify tumors into three main types according to the tissue that predominates; as connective tissue tumors, epithelial tumors, including those developed from both epiderm and hypoderm; and a mixed type which contains tissues derived from two or three embryonic layers. This is indicated in the following classification:

CONNECTIVE TISSUE TUMORS

Fibroma—a tumor composed of fibrous tissue—benign.
Lipoma—a tumor composed of fatty tissue—benign.
Chondroma—a tumor composed of cartilage—benign.[4]
Osteoma—a tumor composed of bone—benign.
Angioma—a tumor composed chiefly of blood vessels—benign.
Myoma—a tumor composed of muscle fibres—benign. There are two types of myoma: leiomyoma composed of smooth involuntary muscle, the most common tumor of the uterus, and rhabdomyoma, of striated voluntary muscle, a very rare tumor.

[4] It is sometimes difficult to distinguish between the benign chondroma and the early stage of chondro-sarcoma. (Bloodgood.)

Sarcoma—a tumor composed of any connective tissue that has reverted to its embryologic type—a typically malignant tumor.

EPITHELIAL TUMORS

Papilloma (*warts*)—a tumor of pavement epithelium with normal connective tissue—benign.

Adenoma—a circumscribed tumor of glandular epithelium with a structure similar to the gland it arises from—benign.

Carcinoma—a general term including all malignant epithelial tumors.

Epithelioma—a malignant tumor of pavement epithelium.

COMPLEX TUMORS

Mixed tumors—fibro-myoma, chondro-epithelioma, adenosarcoma, etc. These tumors are malignant when one of the components is either carcinoma or sarcoma.

Teratoma—composed of tissues and organs of the three germinal layers of the embryo. Dermoid cysts and embryomata. Dermoid cysts often contain hair or fully developed teeth. Embryomata are similar cysts containing more or less fully developed parts or organs of a foetus. Non-malignant.

Carcinoma and sarcoma are classes of tumors which are further subdivided according to the nature of the cells of which they are composed; as epithelioma, Basal-cell cancer, adeno-carcinoma, spindle-cell sarcoma, round-cell sarcoma, giant-cell sarcoma.[5] These terms are very useful to pathologists, because the degree of malignancy is closely associated with the nature of the cells of which the tumor is composed. As a rule the degree of malignancy is proportional to the smallness of the cells and the extent of their reversal to embryonic type.

From this elementary classification, it may be seen that carcinomas are malignant epithelial tumors, and it is these that are technically called cancers. Sarcoma, although typically malignant, is derived from connective tissue and is generally called by that name by physicians. Sarcomas are not nearly so common as carcinomas, and have a distinct tendency to occur at earlier ages than carcinomas.

Both of these classes of tumors are commonly called cancer by the laity, and the use of this term is justified for lay purposes,

[5] The majority of students look upon the giant-cell sarcoma as practically a benign tumor as it is mostly a local growth, usually of bone, and seldom causes metastases. (Bloodgood.)

since it thus includes all malignant tumors. For statistical purposes, also, all sorts of carcinomas and sarcomas are classified together as cancers, because this is the best method of showing the percentage of the population that died from malignant tumors. Consequently in the International List of Causes of Death, we find seven rubrics under which cancer is reported for each part of the body as "cancer and other malignant tumors."

TABLE 42

Crude death rates from cancer per 100,000 population in England and Wales

Year	1840	1850	1860	1870	1880	1890	1900	1901	1902	1903
Rate	17.7	27.9	34.3	42.3	51.2	67.5	82.8	84.3	84.6	87.4
Year	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
Rate	88.2	88.9	92.2	91.5	93.3	96.1	96.7	99.3	102.2	105.5

TABLE 43

Crude death rates per 100,000 for cancer and other malignant tumors in the Death Registration Area of the United States (exclusive of Hawaii), during the period 1911–1922. Registration Area comprises about 85 per cent of total population of United States

Year	1911	1912	1913	1914	1915	1916	1917	1918	1919
Rate	77.4	77.1	79.0	79.6	81.4	82.1	82.0	80.3	80.5
Year	1920	1921	1922	1923	1924	1925	1926	1927	
Rate	83.4	86.0	86.8	89.4	91.9	92.6	94.9	95.6	

IS THE INCIDENCE OF CANCER (MALIGNANT TUMORS) INCREASING?

This would seem to be a most simple question, but it is extraordinarily difficult to answer. Eminent statisticians may be found on both sides of the fence and the ordinary person can hardly be blamed if he concludes that although figures do not lie, liars figure, and that statistics generally are about as unreliable as a lady's watch.

There is one fact on which all authorities are agreed, namely, that the crude death rates from cancer are steadily increasing. Thus we have the statistics shown in table 42, taken from the Report of the Registrar General of England, giving the crude death rates from cancer per 100,000 population in England and

Wales. Similar figures are obtained from the registration area of the United States showing that the increase has continued during later years (see table 43).

Almost everyone beyond middle age knows that he hears of deaths from cancer much more frequently than formerly. The above figures seem at first glance to confirm that impression. But we must beware of both impressions and figures. With regard to the former, we also hear of operations for appendicitis much more frequently during the last thirty years. Appendicitis mortality rates increased 40 per cent between 1900 and 1915. Does this mean that appendicitis occurs more frequently now than formerly, or that the mortality from this disease has actually increased? Not at all. It is only during the past thirty years that physicians have learned to diagnose appendicitis accurately. Before that time patients having appendicitis used to die of "peritonitis." The official death rate has increased for this reason, but the real death rate for appendicitis has undoubtly decreased as the result of improvement in surgical technique and increased willingness of the patient to resort to surgical treatment in the early stages of this condition. Cancer statistics, therefore, do not necessarily reflect the actual facts. Before we can be sure that there is an actual increase in cancer mortality, these crude rates must be corrected, and we must then consider the accuracy of the data (death certificates) upon which these rates are based.

A crude death rate is the ratio between deaths from any cause and the total population, without regard to possible changes in the population in age, sex, and race. If these factors do not change, the crude death rate is a good index of the incidence of any disease, but is very inaccurate if there have been such changes in the population. In the case of cancer, a disease that is rare before thirty-five years of age and increasingly common thereafter, a relative increase in the population of people at the age period thirty-five and over, would increase the number of people in the population susceptible to cancer and the crude death rate would be expected to rise. On the contrary, if there was a relative increase of people of from one to twenty-five years of age, the

cancer mortality rate would drop proportionately. Are there more people living at ages of thirty-five and over than formerly?

TABLE 44

Crude death rates per 100,000 for cancer in thirty-three states

STATE	CRUDE RATE	ADJUSTED RATE
California	121.1	95.1
Colorado	73.8	71.4
Connecticut	105.0	95.9
Delaware	92.4	78.1
Florida	54.3	58.6
Illinois	96.1	90.9
Indiana	95.5	76.9
Kansas	79.6	69.6
Kentucky	54.6	55.9
Louisiana	60.4	76.2
Maine	124.4	86.3
Maryland	99.5	91.2
Massachusetts	116.6	98.4
Michigan	87.7	81.0
Minnesota	93.9	90.0
Mississippi	44.7	56.0
Missouri	85.9	75.0
Montana	57.8	69.6
New Hampshire	136.9	91.8
New Jersey	91.1	90.5
New York	109.2	99.2
North Carolina	46.3	58.0
Ohio	92.3	79.9
Oregon	101.0	85.5
Pennsylvania	86.5	85.2
Rhode Island	121.1	106.9
South Carolina	38.8	53.7
Tennessee	48.2	53.1
Utah	67.4	82.1
Vermont	129.4	88.0
Virginia	57.6	63.3
Washington	90.7	84.1
Wisconsin	92.8	81.7
Average of thirty-three states	86.44	79.67

We have every reason to believe that there are. We have just shown how the death rates from infectious diseases have been

steadily falling with the result that a considerable number of years has been added to life expectancy. There is also a relative difference in susceptibility to cancer in the two sexes, and possibly in different races. We know that there have been changes in the racial constitution of the population during the last fifty years. The crude rates should be corrected for all of these factors.

In comparing the death rate from cancer in one state with that in another, the Census Bureau uses adjusted rates. The adjusted rate makes allowance for the differences in age and sex composition of the populations in the different states, and shows what the death rate would be if all states had the same population of males and females, and the same proportion of the total population in each age group.

Table 44 gives the rate adjusted in this manner as compared with the crude rate for the year 1922 in the following thirty-three states. From this table it is apparent that the cancer death rate, when adjusted to a standard population, is quite different from the crude death rate. In general this adjusted rate is considerably lower than the crude rate. From this it appears reasonable to conclude that when proper allowance is made for the increasing number of people of age thirty-five or over, and other changes in the population, the actual rate for cancer is not increasing as rapidly as the crude rates would signify.

ACCURACY OF DEATH CERTIFICATES

It is commonly assumed that our mortality statistics are accurate, but such is far from being the case even today, and this is particularly true in the case of cancer. Mortality statistics are based on death certificates. Cancer statistics are not strictly reliable because of a basic inaccuracy. Suppose a person is operated on for cancer and dies of post-operative pneumonia. Is the death to be attributed to cancer or pneumonia? Logically, we should say pneumonia, since the cancer might have been cured as the result of the operation if the patient had lived, and in any case, life would have been prolonged several years. But in the official statistics it is thought desirable to get as complete a record as possible of the prevalence of cancer in the population. There-

fore the rule in reporting such a death is, that whatever the actual cause of death, if a person is known to have had cancer prior to death, the death is to be charged to cancer. Thus the official statistics do not tell how many persons died of cancer during a given year, but how many persons died in that year who had had cancer before they died. The latter is necessarily higher than the actual death rate from cancer, and this rule which was adopted in 1903, must have increased the number of deaths attributed to cancer since that date.

Again, in earlier years, the diagnosis of cancer was thought to inflict a stigma on the family, and physicians were urged not to use the opprobrious term on the death certificates. With increasing education, this prejudice against a diagnosis of cancer has decreased, and today it is generally recognized as a perfectly respectable disease, and is so reported.

ACCURACY IN DIAGNOSIS

Death certificates can be no more accurate than the diagnoses of the physicians who fill them in, and no one would deny that there is a great difference in diagnostic skill between physicians. Internal cancers are often difficult to diagnose. No one can be buried without a death certificate, and when any individual dies suddenly, the physician may have seen the patient only a few hours before he died, and may by no means be satisfied as to the cause of death, yet he must fill in the certificate to the best of his ability. Unless he suspects murder, no postmortem examination may be ordered if the family objects. It is certain that if such postmortem examinations were held in all cases in which the diagnosis was doubtful, many more cases of cancer would be diagnosed and reported.

In England and Wales, the death rate from cancer rose from 17.7 in 1840 to 82.8 in 1900. It is quite incredible that the incidence of cancer increased at any such rate. Most of this increase was due to better diagnosis and better reporting of cancer deaths; and it is at least possible that the more gradual increase in the cancer rate since 1900 may be attributable to the same cause.

Returning to the adjusted rate for thirty-three of the United States, the highest adjusted rate is 106.9 per 100,000 for the state of Rhode Island and the lowest is 53.1 for the state of Tennessee. Does this mean that cancer is twice as common in Rhode Island as in Tennessee? Well, that is what the rates for that year say, and we cannot absolutely deny that this is a fact. It might be, for instance, that there is something in the manner of life in the country and small towns that prevents the development of cancer, while in thickly settled regions people are more predisposed to cancer. But everything that we know about cancer leads us to suppose that this is not the case; but that on the other hand, the more enlightened the population, the nearer they are to good doctors and good hospitals, the more postmortem examinations are performed and the more tumors are examined microscopically, the higher will be the death rates for cancer, because the more often will the correct diagnosis be made. Viewed in this light, the low death rate for cancer ceases to be a source of congratulation to the people of Tennessee, and indicates rather a general level of education on a par with their recent law forbidding the teaching of evolution. Certainly such wide variation in the cancer rate in different states indicates that in many localities the diagnosis of cancer is still far from accurate.

That diagnosis has greatly improved in recent years is undeniable and that this is reflected in death certificates is readily proved. No one dies without a cause. There is always some pathological change which is the immediate cause of death. In former years many deaths were attributed to senility or to causes unknown. The combined death rate for senility and ill defined causes has declined in the ten original registration states from 293 per 100,000 to 39.1 in 1920, a decrease of 87 per cent.

Non-malignant tumors seldom kill, and any large number of deaths ascribed to non-malignant tumors are presumably caused by cancers that were not diagnosed. In 1900 the death rate for non-malignant tumors was a little over 12 per 100,000 for persons forty years of age and over, while in 1920 it had declined to 7.9. A considerable part of the increased rate for cancer is certainly to be attributed to this improvement in diagnosis and reporting and

it is at least possible that all of the increase in recent years may be so explained. Statisticians differ radically on this point, and this is the reason that no absolute answer can be given to the question whether cancer is increasing.

It appears to the writer that all of the increase in cancer may be attributed to improved diagnosis. In 1902 it was shown in Berlin hospitals, that 22 per cent of cancers demonstrated at the postmortem, were not recognized during life. This means that in Berlin at that time, there was still a chance for at least a 20 per cent increase in the mortality from cancer, because of improved diagnosis alone, without any actual increase in the incidence of the disease. Lubarsch in a later investigation of practically all the postmortem examinations performed in Germany during 1920–1921 concluded that 50 per cent of cancer cases in Germany are not recognized during life. In Poland in 1926, 31.1 per cent of cancers found at postmortem were unrecognized during life.

In 1914 the United States Bureau of the Census published a report on the "Mortality from Cancer." Of the 50,000 cases of cancer investigated, it was found that in only 2 per cent of the cases was the diagnosis confirmed by a postmortem, and in 9 per cent more an operation confirmed the diagnosis. Thus 11 per cent, or 5500 cases were classified as reasonably certain to be cancer. There were estimated to be 8500 deaths due to cancer of the breast, buccal cavity and skin, all so situated that no mistake in diagnosis would be probable. These also were classified as reasonably certain malignancy. In the remaining cases, letters were written to the physicians and replies were sent in about 80 per cent of the cases. The Bureau was able to compile 30,555 deaths of the original 50,000 as follows:

Diagnosis reasonably certain	58.3
Diagnosis uncertain	27.5
Diagnosis unknown	14.2

Thus in the United States in 1914, there was an admitted lack of precision in the diagnosis of cancer of 14.2 per cent and a possible error of 41.7 per cent. If we assume on the basis of these figures that in 1914, 30 per cent of cancers occurring in the

United States were undiagnosed, the rate of 79.6 for the registration area in that year would become 103.4, a rate that has not yet been recorded but that soon may be attained. (The rate in 1927 was 95.6.)

Moreover as late as 1923, Wells studied a series of 3712 postmortems at the Cook County Hospital in Chicago and found

TABLE 45

Average rate of death per 100,000 living inhabitants by five-year periods, from cancer and other tumors, and from senility and causes unknown in adults, from 1812 to 1920, inclusive

PERIODS	CANCER	TUMOR	CANCER AND TUMOR	SENILITY	CAUSES UNKNOWN	SENILITY AND CAUSES UNKNOWN
1812–1815	4		4	145		145
1816–1820	8		8	123		123
1821–1825	4	1	5	120	39	159
1826–1830	9		9	119	56	175
1831–1835	7	1	8	126	30	156
1836–1840	8	2	10	95	22	117
1841–1845	9	3	12	76	40	116
1846–1850	10	3	13	96	74	170
1851–1855	11	2	13	100	56	156
1856–1860	11	3	14	94	73	167
1861–1865	14	2	16	85	63	148
1866–1870	19	4	23	89	62	151
1871–1875	24	6	30	100	36	136
1876–1880	47	7	54	72	4	76
1881–1885	47	4	51	77	3	80
1886–1890	57	6	63	74	1	75
1891–1895	59	6	65	80		80
1896–1900	66	7	73	65		65
1901–1905	76	8	84	54		54
1906–1910	84	5	89	41		41
1911–1915	97	4	102	28		28
1916–1920	106	5	111	12		12

that 32.7 per cent of the cancers occurring in these individuals had not been recognized during life.

With errors in diagnosis of such magnitude, occurring in a large city like Chicago, we cannot regard small fluctuations in the cancer rate of the registration area as having much significance, and the regular yearly increase may well be due to more accurate diagnosis in death certificates.

One of the most illuminating discussions on the incidence of cancer in recent years is that of Howard on the "Course of Mortality from Cancer in Baltimore." Deaths from cancer were recorded in Baltimore since 1813, and were classified by organs since 1875. Over this period of one hundred and eight years, the crude mortality rate per 100,000 agrees in general with similar rates observed elsewhere. During the last forty-five years the mortality from all tumors has increased by 100 per cent. During the last one hundred years the death rate from tumors has increased nearly 1300 per cent. Since 1900, the crude rate for

TABLE 46

Average rate of death per 100,000 living inhabitants by five-year periods, from cancer, from 1876 to 1920, inclusive

PERIOD	GRAND TOTAL	TOTAL RUBRICS 40 AND 41	RUBRIC 40, ESOPHAGUS STOMACH, AND LIVER	RUBRIC 41, INTESTINE RECTUM AND PERITONEUM	TOTAL RUBRICS 42 AND 43	RUBRIC 43, BREAST	RUBRIC 42, UTERUS OVARIES AND PELVIS	ALL OTHER ORGANS
1876–1880	47	17	15	2	18	6	12	12
1881–1885	50	20	16	4	19	7	11	11
1886–1890	57	25	20	5	22	8	14	10
1891–1895	59	25	21	4	22	8	15	11
1896–1900	66	29	26	4	23	8	16	14
1901–1905	76	38	31	8	21	8	13	16
1906–1910	84	42	34	8	23	8	15	19
1911–1915	98	48	37	11	25	9	15	26
1916–1920	106	52	39	13	27	10	17	27

cancer alone has increased by 40 per cent. This striking increase in the crude rate for cancer is shown by table 45. This table also gives a partial explanation for this increase. It shows that the number of deaths attributed to senility and from causes unknown have declined as regularly as the cancer rate has increased. The almost complete disappearance of senility and causes unknown in the reports since 1890 can mean only one thing, namely that diagnostic ability as reflected in death certificates has improved wonderfully in Baltimore during those years.

The importance of improved diagnosis may be shown in another way. Cancer of the breast is common and readily recognized in fatal cases, and cancer of the female genitals is also readily diag-

nosed in fatal cases. Table 45 shows that there was very little increase in mortality from these readily recognizable cancers.

On the other hand, cancers of the internal organs are diagnosed with difficulty. Cancer of the stomach is even yet often undiagnosed, although methods of diagnosis have improved greatly since 1875. As the stomach is one of the commonest sites of cancer in both sexes, greater precision in diagnosis should have increased the rate. The same argument holds for cancer of the liver and intestine, and in fact these rates have greatly increased. The rubric, "all other organs," includes cancers of lungs, bladder, kidneys, pancreas, suprarenal glands, etc. The diagnosis of all such internal cancers has improved, and the rates have increased. Thus while the total rate for cancer during these years rose 125 per cent, the rates for cancer of the breast and of the female genital organs rose only 67 and 42 per cent respectively. But the rate for cancer of the stomach and liver rose 160 per cent, and the rate for cancer of the intestines 550 per cent (see table 46).

CORRECTION OF FIGURES FOR AGE

Between 1830 and 1920 the percentage of the population of Baltimore of thirty years and over increased from 29.2 to 54.8 per cent of the whole population; that part of the population forty years of age and over increased from 15.7 to 28.5 per cent of the whole population. Increases in the sixth, seventh, and eighth decades exert even more marked influence on the cancer risk. From 1890–1920, the proportion of the population in these three decades increased by 21.0, 26.0 and 19.0 per cent respectively. Since only a small proportion of cancer deaths occur under forty years of age, this change in the age group of the population accounts for a considerable part of the large increase in the crude death rates for death from cancer. The closer the correlation for the age factor, the smaller is the increase in the rates. Thus we have in the following table the crude death rate for cancer of the breast and genital organs per hundred thousand living female inhabitants. The increase in these rates is apparent (see table 47).

As for practical purposes these cancers are confined to the age

period of forty years and over, the above rates have been corrected for this age for the census years 1880–1920. Table 48, with rates, so corrected, gives the rates for that part of the population actually exposed to the risk of dying from cancer of those organs. From this table it may be seen that in Baltimore there was no increase in the mortality rate from cancer of the

TABLE 47

Rate of death, per 100,000 living female inhabitants by five-year periods, from cancer of the breast, uterus, ovaries and pelvis, from 1876 to 1920, inclusive

PERIOD	TOTAL	BREAST	UTERUS, OVARIES AND PELVIS
1876–1880	34	12	22
1881–1885	36	14	22
1886–1890	42	16	26
1891–1895	43	15	28
1896–1900	44	14	30
1901–1905	40	15	25
1906–1910	45	16	30
1911–1915	48	18	30
1916–1920	53	20	33

TABLE 48

Number of deaths and rate of death, per 100,000 living female inhabitants forty years of age and over, from cancer of the breast and uterus, for the census year 1880 to 1920, inclusive

YEAR	TOTAL		BREAST		UTERUS	
	Deaths	Rate	Deaths	Rate	Deaths	Rate
1880	94	61	37	24	57	37
1890	158	76	50	24	108	52
1900	161	64	52	20	109	43
1910	199	65	74	24	125	41
1920	205	48	80	18	125	30

breast since 1880, and none for cancer of the uterus since 1890. On the contrary, since 1880, there has been a decrease in the mortality rate from cancer of the uterus, and since 1910, a decrease in the mortality rate from cancer of the breast. It seems fair to conclude from these figures that for the past forty years there has been no increase in the incidence of cancer of these

organs. On the contrary where the rates are corrected for age there is a considerable decrease. Since no one claims that the incidence of cancer is greatly decreasing, and since spontaneous recovery is practically unknown, this reduction over the last twenty years can only be attributed to earlier diagnosis and surgical treatment. This point should be emphasized for it points the way to our most promising method of dealing with the cancer problem.

TABLE 49

Mortality from cancer (all forms); Death rate per 100,000, and absolute and percentage annual increase or decrease, by age groups, 1911–1922. Industrial Department, Metropolitan Life Insurance Company

AGE PERIOD	DEATH RATE PER 100,000, 1911–1922	AVERAGE ANNUAL INCREASE OR DECREASE, 1911–1922	
		Absolute (in deaths per 100,000 per year)	Percentage of death rate, 1911–1922
All ages, 1 and over	78.5*	+0.58	+0.73
1 to 24	2.7	+0.03	+1.00
25 to 34	16.3	+0.06	+0.37
35 to 44	75.0	−0.37	−0.49
45 to 54	196 2	−0.89	−0.45
55 to 64	390.3	+2.49	+0.64
65 to 74	648.1	+9.14	+1 41
75 and over	879.2	+13.62	+1.55
Group ages:			
25 and over	156.7*	+1.11	+0.71
45 and over	324.5*	+2.87	+0.88

* Based upon "standardized" death rates, i.e., the color, sex, and age composition of the group has been held constant throughout the period 1911 to 1922.

Figures have been compiled by Dr. Louis I. Dublin, the statistician of the Metropolitan Life Insurance Company which give properly corrected data regarding changes in the cancer death rate of policy holders of that company. There were about 14,000,000 insured persons during 1922 (see table 49). In this selected group of persons there was a slight decline of the cancer rate between the ages of thirty-five to fifty-five during the twelve-year period. Beyond the age of fifty-five there was a slight increase, and the more advanced the age, the greater the

rate of increase. If the age forty-five and over is taken, there was an average annual increase of 2.87 deaths per 100,000 for each year between 1911–1922. This small increase can be accounted for by increasing accuracy in diagnosis.

From all these figures we may conclude that although the crude rates for cancer are increasing steadily, a considerable portion of this increase is caused by the increasing proportion of people of age thirty-five and over in the population who are susceptible to cancer. Rates properly corrected for age and sex usually show that deaths from cancer are increasing less rapidly than the crude rates indicate. That the remaining increase may possibly be explained by improved accuracy in diagnosis, and that cancer is actually no more frequent now than it was formerly. That since all cancer cases are not yet diagnosed, we may expect the cancer rate to continue to increase as diagnosis and reporting are improved until the statistics reflect the actual incidence of cancer. We cannot be absolutely sure of these conclusions, but we can at least be sure that cancer is not greatly increasing. It is prevalent enough now to make it a subject of lively interest to every one who is forty years of age or over or who expects to live to that age. We must bend every energy to the solution of the problem. But we need not be terrified by the idea that the disease will continue to increase without limit.

WHAT IS THE CAUSE OF CANCER? (MALIGNANT TUMORS)

Malignant growths include sarcomas and carcinomas, and there are a number of varieties of both of these types of tumor. It is therefore a mistake to regard cancer as an entity which must have a single cause. The proper form of the question is what are the causes of cancer? We do not know all the causes but we certainly do know some of them. Other causes frequently assigned are at least questionable, and the subject may be clarified by discussing the latter first.

IS CANCER A DISEASE OF CIVILIZATION?

Hoffman as a result of a very extensive survey of the mortality statistics in all parts of the world, has drawn the conclusion that

cancer is exceedingly rare in primitive races, while it is increasing rapidly among the more civilized peoples, and that cancer must therefore be caused largely by some condition associated with present day conditions of European and American life. We have already seen that the belief that cancer is increasing rapidly in the United States is at least questionable. The evidence that cancer is extremely rare in primitive races is still less conclusive. Hoffman states that cancer is quite rare among American Indians

TABLE 50

Mortality from cancer in the countries of Asia

	POPULATION	DEATHS FROM CANCER	RATE PER 100,000 POPULATION
Ceylon	20,076,320	1,133	5.6
Hongkong	1,737,310	140	8.1
India	4,456,200	522	11.7
Japan	242,460,425	145,965	60.2
Penang	1,391,089	143	10.3
Philippine Islands	1,190,154	325	27.3
Shanghai	68,684	38	55.3
Singapore	1,434,780	181	12.6
Total	272,814,962	148,447	54.4

Note: The data are given for Ceylon, 1907–1911; for Hongkong, 1907–1911; for India, City of Calcutta, 1908–1912; for Japan, 1905–1909; for Penang, 1909–1913; for Philippine Islands, City of Manila, 1909–1913; for Shanghai, 1909–1913, Europeans only; for Singapore, 1906–1910.

and that cancer of the breast is practically absent among their women. That when negroes were slaves, negro women almost never suffered from cancer, whereas now that they are independent, and live as other people do, they have cancer frequently. Such statements are little more than impressions. There are no accurate statistics to confirm or disprove them.

Hoffman also furnished statistics and among many tables illustrating the low rates among primitive peoples is table 50. All such statistical evidence is based upon the reliability of death certificates. These are subject to considerable error in countries like the United States and England, and in many of the countries quoted are utterly unreliable, as a quotation from an article

written in 1925 by an assistant to the Director of the Philippine Health Service will show:

"In a previous epidemiological investigation on dysentery in one province, it was ascertained that the causes of death of 55 per cent of the total were determined by municipal secretaries and sanitary inspectors, and of the remaining 45 per cent by qualified presidents of sanitary divisions and medical private practitioners. Even admitting 45 per cent correctly reported, the error is appalling. We cannot at present claim to be able to make a very accurate statistical study on the causes of death."

Dr. Dudley, an American physician who has been in practice in Manila for many years, and who believes that cancer exists in the Philippine Islands to a greater extent than in the United States, states that in 1907 there were 7613 deaths in the city of Manila, and of these 3324, or 43 per cent died without medical attendance. If this could occur in Manila, where the number of physicians, both American and Filipino is relatively large, what of the provinces? There the majority of the Filipinos are born and die without ever seeing a physician. But no one can be buried without a death certificate, and so some municipal official fills them in. With the exception of Japan, there is no reason to suppose that the rates for other Asiatic countries are much more accurate.

On the other hand, the more we learn concerning such races, the higher becomes the mortality from cancer. Thus Madden, Professor of Surgery in the Government School of Medicine in Cairo, Egypt, wrote, "Malignant disease among tropical and semi-tropical peoples, even in the black races, is much more common than is generally believed as figures prepared for the Cancer Research Committee show." Sir Leonard Rogers has analyzed the data from 1600 postmortems at Calcutta as compared with a similar series at St. Mary's Hospital, London. Taking the age difference into account, the data show no greater incidence of cancer in England than in India. Rogers concludes that malignant tumors are about equally common in Bengal and England with a slight excess in the tropical country.

In the hospitals of Manila, cancer is the cause of admission in a considerable percentage of cases. In the San Juan de Dios Hospital, during 1902, there were 1679 admissions, of which 36, or 2.5 per cent were cancer. The percentage steadily rose for ten years so that in 1911, out of 848 patients admitted, 40 or 9.88 per cent suffered from cancer. Of 377 cases coming to operation at St. Paul's Hospital, from September, 1907, to December, 1908, 65 or 17.4 per cent were for tumors, of which 37 were benign and 28 malignant. In the Philippine General Hospital from 1915 to 1921, out of 7545 male cases admitted, 150, or 1.98 per cent were cases of cancer. From 1918 to 1921, of 3467 female admissions, 223 or 6.4 per cent were caused by cancer.

The writer has analyzed a series of 8960 postmortems on Filipinos performed at the morgue of the Philippine Medical School, Manila, between 1907 and 1923, with the result that 233 malignant tumors or 2.6 per cent were found that had not been included in the official death rates for Manila. The average death rate for resident Filipinos in Manila from 1915–1924 was 2977 per 100,000. In order to obtain a correct cancer rate for the Filipinos of Manila, 2.6 per cent of 2977 or 77.40 must be added to the average reported cancer rate of 29.60, making a cancer rate of 107 per 100,000. This is a higher rate than has ever been reported for the United States, and certainly lends no support to the opinion that cancer is less frequent among Filipinos than among Americans.

We have no accurate statistics concerning the causes of death among Asiatic races, and the more we learn of them, the more it appears that they suffer from cancer to quite as great an extent as the people of Europe or America.

Finally we may point out that cancers of the most varied character occur in all the lower animals. It can hardly be supposed that these are caused by their high degree of civilization, especially as cancers have been found in wild animals. Cancer is not a purely human disease, and any satisfactory explanation of the disease in man should also explain its occurrence in lower animals.

INFECTION AS A CAUSE OF CANCER

Infection has often been suggested as a cause of cancer. Are any malignant tumors caused by infection of any nature? There is some experimental evidence that malignant tumors of plants may have been produced in this way, but no evidence as yet that tumors of animals are so produced. Erwin Smith has demonstrated that tumors having practically all of the characteristics of human cancers (unlimited lawless growth and formation of metastases), can be produced in plants by the inoculation of plants with a species of bacterium which he has called *Bacillus tumefaciens*.

Peyton Rous succeeded in producing regularly in fowls a peculiar form of sarcoma, by inoculating them with a filtrate obtained originally from a spontaneous sarcoma of the fowl. It is well known that if any cells from such a sarcoma are injected into a healthy fowl, they will grow and reproduce the tumor. The original sarcoma was macerated and the tissue juice treated by three methods to eliminate sarcoma cells from the material to be inoculated; desiccation, glycerination, and filtration through a Berkefeld filter which removed all ordinary bacteria. This filtrate when injected into the breast of normal fowls, invariably produced sarcomas having all the microscopic characteristics of the original tumor. By employing these processes it was thought that no living sarcoma cells were present in the inoculated material and that therefore when a tumor was produced, it was caused by a filterable virus.

Recent investigations have shown that this conclusion is very doubtful. Nakahara, a Japanese investigator, working with the same material, has found that neither desiccation nor glycerination kills all of these sarcoma cells, and that the Rous fowl sarcoma contains a group of minute amoeboid cells that readily pass through bacteria tight Berkefeld filters. Therefore, this fowl sarcoma can no longer be regarded as caused by a microorganism.

But granting that the fowl sarcoma has been really produced by the action of a filterable virus, it must still be emphasized

that only the virus that produces this particular variety of fowl sarcoma has been discovered, and no proof has yet been afforded that any human tumors are produced by such infection.

We know on the other hand that a number of tumors can be produced by various irritations totally apart from bacterial or other infection. Indeed, Maximow found in 1925 that cells from the mammary gland, which could be cultivated in the test tube in proper culture media, under certain circumstances developed cancerous change without the addition of any foreign substance. This affords experimental proof for the theory that has always been advanced by certain pathologists that epithelial cells may of themselves under certain circumstances, take on malignant properties and originate cancerous growths. Even though it may be proved in the future that certain microörganisms have the power to produce human cancer, it seems probable that the action of such microörganisms will merely be one of the numerous forms of irritation known to produce cancer.

In the meantime, it should be clearly stated that cancer is not ever infectious in the ordinary sense of the word. It is practically never transferred from contiguous surfaces, as from one lip to the other, and never from one patient to another. Even the most intimate contact fails to transfer such a growth from one person to another. The wife does not contract cancer from her cancerous husband. We need have no fear that we can be infected by cancer through caring for cancer patients or by intimate association with members of the family who may be so unfortunate as to develop this disease.

CANCER RESEARCH IN ANIMALS

Cancer is widespread throughout the animal kingdom, occurring in amphibians, reptiles, fish, birds and mammals. From 5 to 8 per cent of sick dogs suffer from cancer, and mice and rats suffer from a multiplicity of tumors, including a cancer of the breast and cancers of other organs quite analogous to those occurring in the human race.

Experiments on animals were performed as far back as 1775, when Peyrelle attempted to transfer a cancer of the human breast

to a dog. Many similar attempts have been made even in recent years and using anthropoid apes, but no human cancer has ever been transferred to animals. When human cancer tissue is implanted in an animal, the graft simply dies out, because the cells, of one species cannot survive in another species. But every essential characteristic of human cancer may be found in the spontaneous cancers of rats and mice and it is quite possible to transfer such a cancer from one mouse to another. This was first accomplished in 1889 by several independent observers. Moreau in France, succeeded in inoculating eight out of ten mice with a cancer and by 1894 he had passed this cancer through seventeen generations of mice. Many other observers engaged in this work. Jensen in 1902 propagated a strain of mouse cancer that has been used in many laboratories.

It was soon realized that it was possible to learn much concerning the nature of cancer by studying the disease experimentally in these animals, and during the past twenty-five years the experimental study of cancer has been pushed in all countries where any medical research of importance is carried out. We have learned:

1. That in the beginning cancer is localized. All the cells of a cancer are the descendents of one or at most a few cells that have taken on the abnormal cancerous characteristics. Cancer is therefore curable if diagnosed and removed at this stage.

2. Cancer cells are potentially immortal, and will continue to multiply so long as a suitable host is provided. We know this because one strain of mouse cancer has been transplanted from mouse to mouse through several hundred generations during a period of twenty years and still shows its original vitality, and retains its special biological characteristics.

3. That it is highly improbable that cancer is infectious. Not only has experience with animal cancers confirmed the evidence from human sources that cancer is not contagious, and cannot be transferred from one individual to another by even close daily and intimate association, but every characteristic of these experimental tumors indicates that the cancerous changes in the cells is not initiated by any infectious agent. For although can-

cer is widely distributed among all vertebrate animals showing that their cells are capable of undergoing cancerous change, yet it cannot be transmitted even from one closely related species to another by the inoculation of cancerous material. Each cancer is specific to the species in which it originated, and we cannot transmit the disease by inoculating the cancer cells of a mouse into a rabbit or even the very closely related rat. No human cancer has been transmitted to animals. If there is any infection contained in these cancer cells, it behaves differently from all other known infections which have been studied by precisely this method of transferring the infection from one species of animal to another. Still further, if infection is inoculated into an animal, it produces disease in that animal's own tissues. But when a cancer is transplanted from one mouse to another, the cancer that develops in the second mouse is composed solely of the cells from the first mouse, growing like a parasite in its host. Such facts cannot be reconciled with an infectious origin of the disease.

4. Most important of all, it has been learned that it is possible to originate cancer in animals by certain forms of irritation. This was shown clearly by the work of two Japanese investigators Yamagiwa and Ishikawa who in 1918 produced cancer in normal rats and mice by repeated applications of tar. Cancers so produced can be transplanted from mouse to mouse and behave in all ways like spontaneous cancers. Other similar substances have since served to produce cancer in animals including paraffine oil and isoprene. It has been noted that the cells in contact with the tar degenerate. Other cells grow to replace this defect and if the stimulation is repeated sufficiently often, the cells so continuously stimulated to regenerate finally acquire the property of independent growth. The injection of drops of coal tar into the tissues has also been found to draw the tissue cells toward the tar, thus building up a dense mass of cells relatively devoid of intercellular substance and blood vessels. Such cells are improperly nourished and therefore grow atypically and finally independently. According to this view any tissue may become cancerous by the action of an agent that frees the cells from their intercellular substance and an active circulation of

blood. Those experiments have therefore explained the origin of cancer cells. As the result of irritation, normal cells acquire the property of growing in the lawless manner characteristic of cancer cells.[6]

IRRITATION AS A CAUSE OF HUMAN CANCER

These experimental facts are in harmony with observations on man, for authorities have recognized for many years that certain types of human cancer originated in very definite parts of the body as the result of prolonged irritation of various kinds.

Workers in tar and paraffine suffer disproportionately from cancer of the skin. It is a significant fact that these same substances produce cancer either in man or animals. Cancer of the bladder and kidney are abnormally frequent among aniline workers. Aniline is also a coal tar product, that may be absorbed, and excreted in the urine.

Chimney sweeps were peculiarly liable to cancer of the scrotum caused by the soot which settled in the folds of the skin of this region.[7]

Mule spinners are likewise very susceptible to cancer of the scrotum owing to prolonged contact with petroleum oils. Statistics gathered in England showed that the incidence of cancer of the scrotum in the general community was 4.1 per

[6] In the experimental production of cancer of the skin in animals by irritants, there is an interval of time between the local growth so produced which may be morphologically cancer (having cells that resemble cancer cells in form and structure) and the development of typical cancer cells having in addition the physiological property of indefinite and independent growth. If the irritation stops before the appearance of physiological cancer cells, the local growth disappears spontaneously. This local growth may be called a precancerous lesion, and similar precancerous conditions have been recognized in man. At present, the entire hope of preventing cancer rests upon the recognition and removal of these precancerous areas, before their cells become physiologically cancerous. (Bloodgood.)

[7] In chimney-sweep cancer of the scrotum, Leitch of England explained the fact that the scrotum only is involved, and not also the skin of the thigh, by the presence of the oily secretion in the scrotum. This, mixed with soot, produces an irritant which causes cancer. That is, many students of chronic irritation are inclined to the opinion that there must not only be an irritation over many years, but some specific substance, and undoubtedly more than one. (Bloodgood.)

1,000,000; among spinners it was 134 per 1,000,000; among chimney sweeps 534, and among patent fuel workers (briquette makers) it was 608 per 1,000,000.

Heat is another form of irritation that produces cancer under certain circumstances. Among the natives of Thibet there is a peculiar custom of keeping warm by wearing a charcoal stove over the abdomen, and they develop a cancer of the skin in the exact area constantly irritated by the stove. Smokers are especially liable to cancer of the lip and tongue, and these cancers are common among men and rare in women. In the United States during the decade ending in 1920, there were 2361 deaths from cancer of the lip among men as compared with 180 among women, and there were 10,114 deaths from cancer of the tongue among men as compared with 1009 among women. In England, the Cancer Research Council investigated the statistics of cancer in different trades and professions, and found that among open air workers, including agricultural laborers, seamen, dock laborers and railway men, cancer of the lip was from two hundred to three hundred times in excess of the rate for the rest of the community. These men are pipe smokers, and the pipe, particularly the clay pipe, irritates the lip in a manner peculiarly productive of cancer.

Cancer of the larynx was disproportionately high in musicians, army officers and law clerks, whose occupations cause a continued irritation of the throat. Cancer of the bowel was above normal in barristers, solicitors, bankers, clerks, teachers, clergymen and others of a sedentary occupation in whom irritation of the bowel is produced by habitual constipation.

The oriental habit of chewing of betel nut is a cause of cancer of the buccal cavity, particularly of the cheek where chewers keep the quid. In India out of 1700 reported cancer cases, 71 per cent were of the buccal cavity, while other observers claim never to have seen a cancer of the mouth in a non-chewer of betel nut. Among Filipinos 12.66 per cent of cancers in males and 17 per cent in females are cancer of the cheek, all caused by chewing betel nut. The women are more addicted to this habit than the men.

Finally we come to the cancer produced by the Roentgen rays,

commonly called x-rays. When this method of diagnosis was first introduced into medicine, this property of the x-rays was not known or suspected. Single exposures or even fairly frequent exposures separated by a considerable time interval appear to be quite harmless. Consequently none of the patients developed this trouble. But nearly all of the early workers with the x-rays, who were constantly subjected to them have developed a peculiar carcinoma of the skin, which spreading slowly, necessitates one amputation after another in the attempt to remove it. Thus nearly all of these early workers have lost most of their fingers or arms, and not a few of them have died from x-ray cancer which was inoperable. Today workers with x-ray protect themselves by standing behind a lead screen and by wearing lead-lined gloves. This well-known x-ray cancer is one of the most undoubted instances of the production of a malignant tumor purely by long continued irritation, in this case by a form of light.

Certain long continued bacterial irritations such as tubercular and syphilitic lesions favor the production of cancer. Cancers sometimes form in scars, or from moles,[8] and there are a number of authentic instances in which sarcoma has followed some injury such as a blow. It appears probable that certain long standing forms of irritation cause a slight inflammatory reaction, with the destruction of tissue and its subsequent replacement. When this process acts over a sufficient length of time, it results in a certain abnormality in the form and arrangement of the cells. That is, they become cancer cells.

As the result of experimental work and observation, we now understand that certain long continued irritations, whether the result of mechanical friction, heat, application of chemicals, Roentgen rays and radium, or by animal parasites or bacteria, have a tendency to produce cancer. And since many cancers can indubitably be produced in this manner, it seems probable that irritation of some form is the most common cause of cancer.

It is to be noted that certain parts of the body that are continu-

[8] Cancer is rare in ordinary scars. Elevated, pigmented moles, whether warty or not, are very prone to malignant degeneration. All elevated pigmented warts or moles are dangerous. (Bloodgood.)

ally irritated never develop cancer. There is no part of the body where irritation of all kinds is so common as the palmar surface of the hand and the feet. The majority of people suffer at one time or another from corns produced by the rubbing of the shoe, yet cancer of the hands and feet are practically unknown. On the other hand other locations are peculiarly liable. These include the face, lips, buccal cavity, stomach, lower bowel, and the breast and uterus. We are totally unable to explain why some portions of our anatomy are so much more subject to the disease than others. But we can note the fact and avoid as much as possible the forms of irritation that are known to provoke cancer.

It is well-known that age is a modifying factor. Most of these forms of irritation do not produce cancer in the young. There must be some tissue change associated with age and even more with senility which predisposes toward cancer. It seems probable that as the reparative processes slow down with advancing years, it becomes harder and harder for the body to readjust itself to these forms of irritation, and that the repair following such mild chronic inflammation is progressively of a poorer quality so that the formation of atypical or cancer cells, becomes correspondingly more frequent.

The objection has been raised that irritation cannot be the real cause of cancer because only a small proportion of all the individuals of cancer age subjected to irritation develop cancer, and tar cancer can only be produced in at most from 60 to 80 per cent of experimental animals. Should not the real cause produce the same result with greater uniformity?

There is a great variation in individual susceptibility to irritation, and this variation has been found to be hereditary.

IS A TENDENCY TO CANCER HEREDITARY?

Many authorities state that this tendency is not inherited, and certainly there are no human statistics that prove that it is. Families in which cancer is unusually prevalent undoubtedly exist. Warthin has recorded one family in which 17 out of 48 descendents of a cancerous grandfather developed cancer. But such families might be explained according to the working of the laws

of chance. The chances are even that any given child will be a boy or a girl, but everyone knows families that have only boys or only girls.

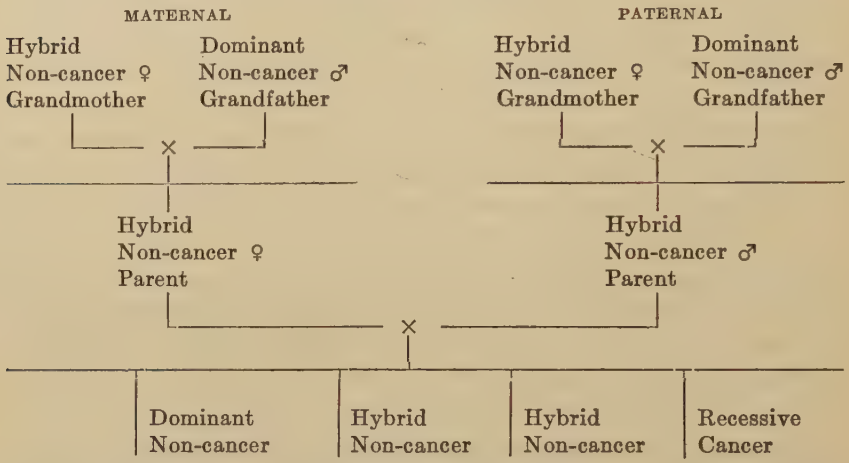
A study was made of the family history in 3000 cases of cancer in certain English hospitals. Of these, only 13.1 per cent had a history of cancer in immediate ancestors, while 417 non-cancerous cases had 14.0 per cent of cancerous antecedents. But if a tendency to cancer is transmitted in accordance with the Mendelian law, such figures can prove nothing. The inheritability of a recessive character cannot be determined by the statistical method. The statistician may determine whether parents or grandparents had cancer; but when they did not have cancer, he cannot ascertain whether those individuals were pure breeding resistant to cancer or were hybrid resistant. This can only be determined by breeding experiments.

Such a tendency to cancer has been proven in animals. Mice suffer from spontaneous cancers, and as an age of three years is extreme old age for a mouse, it has been possible to perform thousands of breeding experiments on these animals through a number of generations.

The most notable investigator of this phase of the problem is Maud Slye who has been engaged on this question over fifteen years and has performed a very large number of such breeding experiments on mice. She has watched the progeny to old age, and performed postmortem examinations on each mouse with a microscopic examination to determine the possible existence and type of tumor produced. According to Maud Slye, inheritance of tumors in mice is that of a Mendelian recessive, and she has been able to cause tumors at will, and even to produce a specific type of tumor in a particular organ. A double cancerous parentage yields 100 per cent of cancerous progeny if the individuals that die before reaching the cancer age are excluded. When both parents are non-cancerous, the off-spring are 100 per cent non-cancerous. Mating of cancerous and non-cancerous mice results in cancerous offspring according to the typical Mendelian ratio.

Since the tendency to cancer is a recessive characteristic there will be hybrids in whom the tendency is recessive and who

therefore do not suffer from cancer, but who can transmit this tendency. As long as such hybrids are mated with dominant non-cancerous individuals, there will be no cancer in the offspring. But should two such hybrids, neither of whom suffer from cancer, be mated, cancer will appear in the offspring. In this manner cancerous individuals may occur in the offspring when neither parent nor any of the four grandparents had cancer. Maud Slye has illustrated this type of transmission in mice as follows:



If the tendency to cancer in mice is a Mendelian recessive, must we conclude that the tendency is inherited in man in the same way? The Mendelian law of inheritance is a general biological law which operates in the same manner whether the experiments be conducted on peas, mice, dogs or man. All of the facts concerning human inheritance have been learned from breeding experiments with plants or the lower animals because these alone can be controlled. Human breeding experiments are impossible. There has been no hesitation in applying the Mendelian law as shown by animals to man in explaining such peculiarities as coloration (black hair, yellow hair, brown eyes, blue eyes), lack of coloration (albinism), or diseases such as color blindness or haemophilia. But there has been a marked reluctance on the part of students of the cancer problem to admit that the facts

reported in the hereditary transmission of cancer in mice can be applied to man. If the tendency to cancer in mice is inherited,[9] such reluctance is illogical, but is quite understandable because if the tendency to cancer is hereditary, there is no immediate prospect that this tendency can be eradicated. However, we cannot dispose of a biological law because it runs contrary to our wishes. If the tendency to cancer is inherited in mice, we must at least assume that it is similarly inherited in man.

Admitting this to be the case, the prospect is still hopeful. Although we cannot hope to eliminate this tendency by controlling human matings, we can give advice which if followed will reduce the prevalence of this tendency considerably. There are obviously few pure breeding cancer strains in the community, for if such strains existed in any considerable number, there would be far more cancerous families than there are. There must be a considerable number of dominant non-cancer individuals, and many hybrids who are not susceptible to cancer themselves though cancer may have occurred in some of their immediate ancestors. If such hybrids marry, the tendency is greatly increased in their offspring. Therefore, one who has had a parent or grandparent who suffered from cancer is presumably a hybrid and should marry when possible, a dominant non-cancer individual, i.e., one who has no such cancer history in any of his ancestors. Further, it must be emphasized that cancer itself is not inherited, but only a tendency or predisposition to the disease. All who inherit this predisposition do not necessarily develop cancer. Some other factor (irritation) acts in the production of the disease. If we can eliminate the influences that produce cancer in those who are susceptible, we may control the disease even though the hereditary tendency still remains.

From all of this discussion of the causes of cancer we may conclude that while much concerning the origin and nature of cancer remains unknown and research must be continued to increase

[9] It must be admitted that Maud Slye's conclusions on the hereditary possibilities of cancer are not accepted by many prominent physicians and students of cancer of this country and abroad, chiefly because her results on mice have not yet been confirmed by independent investigators.

existing knowledge, there is every reason that a general effort should be made both to prevent and to cure cancer by utilizing the information that is at hand. This information may be summarized as follows:

1. Cancer itself is not hereditary, but a predisposition or susceptibility to cancer may be inherited.

2. The commonest cause of cancer is prolonged irritation of certain well known types acting upon susceptible individuals.

3. Cancer is at first a local disease. It never originates at once in widely separated places. It always begins in one spot.

4. If recognized while still localized in that one spot it may be removed completely with every prospect for a permanent cure.

5. If operation is deferred until it has spread to other parts, the condition cannot as yet be cured, though life may be prolonged and ameliorated by proper treatment.

6. The prevention of cancer depends upon the employment of measures of personal hygiene, particularly with regard to the elimination of sources of irritation, and upon the intelligent cooperation of patient and physician in order that all precancerous lesions (i.e., warts, moles and ulcers that are not cancer, but which experience shows often become cancer) should be removed.

7. The cure of cancer depends upon its recognition at the earliest possible moment followed by its prompt and complete removal. In order to accomplish this it is essential that the public should be taught to recognize the earliest symptoms that may be suggestive of cancer, and to apply to a competent physician at once.

PROPHYLAXIS

Prophylaxis consists chiefly in avoiding those irritations that are known to produce cancer, and the removal of precancerous lesions. Cancer of the lip and tongue are among the most common cancers of men, and are chiefly caused by smoking, and particularly pipe smoking. If a man does not wish to stop smoking, he can at least avoid excessive smoking. If he smokes a pipe he can at least buy a pipe with a smooth wide mouthpiece and avoid holding it in such a way that the stream of smoke always impinges

upon one spot on his tongue, and the stem is always clamped against one small area of his lip. Cigars and cigarettes must be discarded before they burn the lips. Rough or decayed teeth are frequent and dangerous sources of irritation. Sharp edges of a tooth cut the tongue or cheek, producing an ulceration that may eventually undergo a malignant change. Pyorrhoea, tartar accumulation, and badly fitting bridges and plates also cause a chronic irritation. Thorough cleanliness and correction of all dental defects will greatly reduce the liability to cancer of the buccal cavity. Cancer in a clean mouth is rare, particularly in a non-smoker. Syphilis of the tongue is an important predisposing cause. This lesion is usually tertiary and would not occur if syphilitic infections were treated early and thoroughly.

Cancers of the skin frequently develop from warts and pigmented moles. Injury or mechanical irritation is frequent in such cases. Increased vascularity and pigmentation, rapid increase in size or superficial ulceration are danger signals that should lead to immediate removal particularly in those forty years of age or over. Any change in an old scar should serve as a similar warning. If such so-called precancerous lesions were removed, it would be rare to find cancer developing on a clean skin. Workers in tar, oil and irritating chemicals must be trained to avoid such contact so far as possible, and to remove all such irritating substances from the skin as soon as the work of the day is over.

The excess death rate of women from cancer is due entirely to malignant disease of the breast and generative organs. In most other parts of the body a considerable excess is recorded for men. Cancer of the breast is more frequent in single than in married women; and of married women, cancer of the breast is more frequent among the less fertile and those who do not suckle their children. The disuse of this organ evidently leads to changes favorable to the development of cancer. Out of several hundred cases in which the history was studied, only a small number had normal gland activity. Mice which have been prevented from suckling their young develop cancer more frequently than normal mice. If cancer of the breast is really unusual among

primitive races, a possible explanation may lie in the fact that among such races, these organs fulfill their physiological purpose in almost all cases, which is by no means the case among highly civilized races. It is possible that an organ that is never used will deteriorate and be more liable to malignant disease than an organ that functions normally. This is in line with the well-known biological principle that unused structures tend to degenerate. This should be an additional inducement to use breast feeding. Among those who suckle their children, and subsequently develop cancer, a history of chronic inflammation of the breast (mastitis) is commonly found. This may be prevented by cleansing the nipple after the nursing, and prompt attention to all cracks or fissures that may develop.[10]

TABLE 51

Death rates for England and Wales per million women living 1911–1913, corrected for age distribution

	SINGLE	MARRIED
Uterus	169	293
Breast	346	238
Ovary	60	31

Cancer of the ovary is also more frequent among single than married but on the other hand, cancer of the uterus is more frequent among married women. In many cases this is due to injuries to the neck of the uterus (cervix) following childbirth that have not been repaired and develop scar tissue or chronic

[10] Many students are of the opinion that chronic cystic mastitis is a precancerous lesion. My investigations over a period of now more than thirty years, which have been published, show no such relationship. Cancer may begin in the breast of any woman after the age of twenty-five. There are definite factors that might lead to prevention. First irritation of the nipple in an adult woman may lead to Paget's cancer, just as a sore nipple may lead to a mastitis with abscess in the nursing mother. The care of the nipple will prevent both. A mastitis, no matter what its cause, and whether it suppurates or not, if it leaves a residual lump, may ultimately, after years, develop into cancer. Therefore this residual lump should always be removed. Every possible tumor in the breast of a woman over twenty-five should be explored. If it is not cancer, remove the lump. If it is cancer, perform the complete operation. (Bloodgood.)

ulceration. All such injuries should be properly repaired. But disuse may also have a deleterious influence. In one series of cases of women who died of cancer of the uterus, it was found that the unmarried died at the average age of forty-nine while the average age of the married was a little over sixty. The effect of marriage on the death rate for cancer of the breast and generative organs is shown in table 51.

The stomach is another organ in which cancer develops frequently. The mucous membrane of the stomach is quite insensitive to pain. It is well known that liquids that burn the mouth can be swallowed and hardly felt in the stomach. Stomach-aches are commonly caused by distention or irritation of surrounding organs and nerves. The habit of eating foods that are too hot or too highly spiced causes a long continued irritation of the stomach, just as the heat from a pipe affects the lips. Ulcers of the stomach often exist for many years and often cause only the symptoms of indigestion, but many such ulcers develop malignancy later. When mice are painted with tar it requires about six months of such treatment before cancer develops. Since the span of life of a mouse is about three years, in man, a similar latent period in the development of malignancy would be ten to twenty years. Cancer of the stomach may therefore develop as the result of a habit formed many years before. Very hot foods, highly spiced foods, and foods known to cause indigestion should be eliminated from the diet. The cause of habitual indigestion should be ascertained and corrected if possible. Gastric ulcers should never be neglected, for they have a pronounced tendency to develop carcinomatous degeneration. They can be cured in a large percentage of cases by appropriate medical or surgical treatment.

The liability to cancer of the intestine and rectum can also be greatly reduced through the correction of chronic constipation, by diet, proper exercise and other measures of personal hygiene.

THE CURE OF CANCER

As the prevention of cancer depends upon the removal of sources of irritation, and of precancerous lesions, so the cure of

cancer depends upon the recognition and removal of cancer at the earliest possible time, while the tumor is still confined to one spot. The difficulty in carrying out this procedure lies in the fact that most people do not recognize cancer at this early stage, when the disease is causing practically no distress. Pain is a late symptom in cancer and when a patient waits until driven to the doctor by pain, it is almost always too late. Many people also dread any operation and therefore put off medical consultation concerning suspicious symptoms or new growths. Thus a cancer that could be removed by a comparatively slight operation with from 80 to 100 per cent probability of cure, develops so that a very serious operation becomes necessary, with greatly reduced prospects of cure. The failure to cure in these cases is due, not to the defects in surgery, but to the delay.

The medical profession has been educating people concerning the first signs of cancer and the necessity for early operation for a number of years. To a certain extent such efforts on the part of the profession have already borne fruit. In cancers of the skin, lip and tongue, successful results may be obtained in practically 100 per cent of cases that are seen sufficiently early. Bloodgood stated some years ago that at the Johns Hopkins Hospital, during five years, the per cent of successful cases increased from 8 per cent to 30 per cent. In cancer of the tongue, the per cent of permanent cures was increased from 21 to 50 per cent. In cancer of the breast, the percentage of permanent cures was increased from 35 to 42 per cent. This improvement was definitely due to earlier operations and not to better surgery. In a letter to the Journal of the American Medical Association on March 26, 1927, Bloodgood wrote that at the Johns Hopkins Hospital, the percentage of inoperable and hopeless cancer has fallen from more than 50 per cent previous to 1900, to less than 5 per cent since 1920. But such results are only obtained in certain localities, where people have learned more concerning the disease.

About 50,000 persons die annually from cancer in Great Britain. The Minister of Health estimated that in from 15,000 to 18,000 of these cases, the disease occurs in regions where early diagnosis allows of a proved curability rate varying in different sites from

60 to 95 per cent. It was estimated that in males at least one-third and in females at least one-half of all cancers are capable of early removal and cure, or a total potential annual saving of about 20,000 lives. Cancer killed approximately 95,504 persons in the United States in 1925. A similar percentage of these persons could be saved.

This further reduction in the mortality from cancer can only be accomplished by educating people to consult good physicians and surgeons earlier concerning certain symptoms and growths that may appear trivial to them, and insistence upon the fact that early operation is not dangerous. For this reason it is desirable to present briefly the early symptoms of cancer of those locations where it develops most frequently.

CANCER OF THE LIP

Every man is warned in time. There is always some abnormal condition of the lip, often a burn from smoking that does not heal. Sometimes there is a crack, or fissure of the lip which alternately appears to heal and then breaks open again. Any crack, fissure or burn of the lip that does not heal, especially if occurring after thirty-five years of age, is a precancerous lesion and may very possibly have already undergone cancerous change. A surgeon should be consulted at once, for when removed within a few weeks, the chances of cure are practically 100 per cent. At this stage, the operation may be performed under a local anaesthetic and causes no disfigurement. As cancer develops, this defect becomes an ulcer which may still be removed with the same prospect of cure *if the lymphatic glands have not become involved.* Such cancers often grow very slowly, and cause little pain or distress, but if deceived by this, the visit to the surgeon is postponed, and the glands of the neck and other regions become involved, a very extensive surgical operation is required to remove such glands, and the chances of cure have been very greatly reduced, if they have not entirely disappeared.

CANCER OF THE TONGUE

Sometimes the tongue becomes covered with glistening white patches or plaques. This condition, occurring usually in smokers,

is called leucoplakia by the surgeon, and is a precancerous condition that frequently develops into cancer. Cancer of the tongue almost always begins as a sore or superficial ulcer, that appears most frequently on the side of the tongue where it comes in contact with the teeth. It also may appear on the tip of the tongue. The ulcer is at first superficial, but later it becomes deeper with hard and prominent edges. It does not cause pain until far advanced. Cancer of the tongue is one of the most distressing forms of cancer, and the glands of the neck are generally involved relatively early. Yet no one can have advanced cancer of the tongue without considerable warning. If such ulcers and abnormal tongues are taken to the surgeon when first noticed, the growth can be removed successfully by a simple operation under local anaesthesia without seriously incapacitating the tongue. Later the entire tongue and the lymphatic glands must be removed, and even then the prospect of permanent cure is greatly reduced.

CANCER OF THE FACE

Cancer of the skin of the face often begins as a firm papule, or as a small rounded or irregular nodule or lump in the skin. Over such a lump, the skin may be shiny and smooth or the surface may become scaly, and bleed when the scales are removed. Such a nodule may remain for months and grow very slowly but eventually it ulcerates and bleeds readily. At other times the cancer begins as a warty growth. The most frequent locations are on the side of the nose or the cheek, but they are common on other parts of the face. Any old warts and moles that show a tendency to grow larger, or to bleed easily, as well as all new growths occurring after forty years of age, are possibly cancer and should be taken promptly to a surgeon for examination. Removal of such lesions is generally advisable and is a simple operation at this early stage.

CANCER OF THE STOMACH

One-third of all cancers in men and one-fifth in women are of the stomach. The early signs of cancer of the stomach are not

recognized so readily because they are similar to the ordinary symptoms of indigestion. An uneasy feeling in the stomach, with acid eructations (belching), nausea or slight vomiting are not characteristic of cancer since they occur in non-malignant dyspepsias. Nevertheless the gradual onset of such symptoms of "indigestion" especially when occurring in a man after middle life, without obvious cause, and in one who has not previously been a dyspeptic should always excite suspicion. Failure of the appetite, and increasing aversion to food, particularly meat, is a common early sign of gastric cancer. If, in addition, these symptoms are not relieved by careful dieting and are followed by loss of weight, the probability of cancer is increased. Those having such symptoms should go to a specialist for a thorough examination of the stomach, including an x-ray examination by means of which any new growth may be detected. An x-ray examination is advisable in every doubtful and unexplained persistent indigestion occurring after middle life.

Later the gastric discomfort develops into definite pain, which is quite constant and not relieved by food. The pain of ulcer of the stomach, on the contrary is often relieved temporarily by taking food. The vomiting becomes more constant and may contain blood of a dark brown color; described by physicians as "coffee ground vomit." Coffee ground vomit only appears after the cancer has undergone ulceration, and the prospect of cure is decidedly less.

The idea of operation for removal of part of the stomach is not at all pleasing. Nevertheless it is the only method that affords any hope at all, and that only when the operation is undertaken sufficiently early. The removal of part of the stomach does not seriously incommode that organ, and it is possible to live tolerably even when the stomach is entirely removed. The duration of life when cancer of the stomach has occurred, and operation refused, may be anywhere from three months to three years. The average duration of life is perhaps one year, and it is not a pleasant life at all. Food eaten is not retained and month by month pain, anaemia and general weakness increase. Cancer of the stomach is one of the commonest forms of cancer in both

sexes, and it is impossible to recommend early consultation and operation too strongly in such cases. In many cases cure is possible. In a considerable series of cases reported from the Mayo Clinic in 1927, 52.5 per cent of the patients operated upon early (before lymphatic involvement occurred) were well and had no recurrence three years after operation. After the lymphatics had become involved, the percentage of cures was reduced to 18. *But only one patient in four admitted for cancer of the stomach had an operable condition, owing to delay and failure to realize the gravity of dyspepsia commencing in middle or late adult life.*

CANCER OF THE INTESTINE

Cancer of the intestine is usually located in the large intestine or colon. The earliest symptom of cancer of the colon is increasing constipation necessitating the use of purgatives in increasing doses, a sign of particular importance in those whose bowels have always been regular. Such periods of increasing constipation frequently alternate with short periods of diarrhoea. These are the symptoms of chronic obstruction of the bowels and are caused by a narrowing of the lumen of the intestine by the tumor. Later the peristaltic action of the bowel above the stricture causes colicky pains, at first slight but developing into cramps that are made worse by taking a purgative. Such pains are often caused by taking food, causing a desire to move the bowels after each meal, a very suspicious symptom. At such times perhaps only mucus tinged with blood may be passed.

Such symptoms call for a physical examination. If cancer is present the x-ray will show a tumor in the majority of cases, and its location. The future of the patient depends on the site of the tumor, but more upon the time at which he presents himself. In cases seen sufficiently early the tumor may be completely removed. It is nothing exceptional for surgeons in these days to remove a considerable segment of intestine with very little risk to the life of the patient, and almost no subsequent inconvenience. Since the adoption of the x-ray in diagnosis, the accuracy of diagnosis of cancer of the intestine has increased very markedly.

CANCER OF THE RECTUM

Cancer of the rectum is twice as common in males, and its symptoms are very similar; increasing constipation in one whose bowels have previously acted regularly, together with the passage of blood stained mucus. Pain is often entirely absent in the early stages. These symptoms should lead to immediate examination with the proctoscope, an instrument that renders the walls of the lower intestine visible.

CANCER OF THE BREAST

Cancer of the breast is one of the commonest forms of cancer in women, and all that has been said already about the necessity of early consultation with a surgeon must be emphasized here. On the average women do not seek medical advice until eight to ten months after the growth was first noticed, which greatly reduces the probability of cure if the growth is cancer. Any woman of any age, but particularly after forty years of age, who detects a lump of any kind in the breast or any abnormal condition of the breast, should consult a competent surgeon without any delay whatever. Many of these tumors are benign and may be removed completely and safely without causing much disfigurement. They should be so removed even if benign, because no one can predict when cancerous change may occur in such a tumor. As soon as the tumor is removed, it is examined microscopically, and if it is cancer, complete removal of the breast and of the lymphatic glands in the axilla (armpit) is necessary. If this rule is followed, all real cancers of the breast will be detected at an early stage while complete removal of the cancer is still possible.

Of early cases operated upon, 94 per cent were well after three years, 91 per cent after five years and 87 per cent after ten years, but in England an investigation showed that only 15 per cent of the women in hospital had sought treatment at a stage when any such results were possible.

Even later cure is often possible. With the modern complete operation, 52 per cent of all patients were well after three years, 39 per cent after five years, and 30 per cent after ten years. The importance of early operation is apparent.

CANCER OF THE UTERUS

This is one of the commonest of cancers among women. Any woman of thirty-five years of age or over who experiences irregularity in the menstrual life or who has any discharge of any character should seek medical advice at once. This is particularly true after the menopause. Haemorrhage is usually the first symptom of cancer of the uterus. Any bleeding or discharge after the cessation of menstruation should be a cause for immediate investigation by a competent surgeon. Pain is usually a later symptom. The operation for cancer of the uterus is not a dangerous operation when undertaken in the early stages of the disease, and affords an excellent prospect for a permanent cure. If not performed early, neighboring organs such as the bladder and the glands in the peritoneal cavity become involved, and a cure is then impossible.

If all patients would bring their complaints to physicians without waiting too long, and would be willing to insist upon having a thorough physical examination, the number of cancers that would be detected in an operable stage would be greatly increased, and the present mortality from cancer greatly reduced.

What are we to say concerning cures by radium and Roentgen rays? It is possible to cure certain superficial cancers by these methods, but almost all of these cases could be cured more certainly by surgical removal. In some instances radium is used following operation to ensure a greater probability of cure in cases in which cure is doubtful from operation alone. Radium and x-ray treatment are of great value in the treatment of cancers that have reached the inoperable stage, where they often afford great relief and may even enable the patient to resume work. In a small percentage of cases, cures have resulted from such treatment of surgically inoperable cancers. But the percentage of such cures is so small that no one should wait or avoid surgical treatment in the hope that radium or x-rays will save them later. As we learn more concerning the best methods of using radium and x-rays, it is possible that we may succeed in curing a larger percentage of inoperable cases. But we cannot

advise anyone to wait for this hope to be fulfilled. When a patient consults an experienced physician or surgeon, the method of treatment best suited to his case will be recommended.

Almost everyone has heard of patients that were cured of cancer by quacks or irregular practitioners who used some kind of paste that "drew the cancer out by the roots." Arsenical pastes have been known since the time of the ancient Egyptians. It is probable that many of the cases apparently successfully treated by quacks today were not cancer at all, but some benign tumor. Caustic pastes merely act by destroying the tissue to which they are applied. They have sometimes been used by reputable physicians to treat inoperable cases of cancer, because they give relief by destroying a large part of the growth. But the probability of eradicating all the cancer cells by this method is exceedingly small, and the use of caustic pastes in operable cases cannot be condemned too severely. Those who are inclined to adopt such a method because they fear operation, should consider that pastes act slowly and painfully and in the end do not cure, while an operation has the advantage of curing in a high percentage of cases, and is concluded promptly and painlessly. Many people dread an operation and seem to feel that when they apply to a surgeon they are to be "butchered to make a Roman holiday." To a certain extent this is a remnant of the dread with which people approached operation in the pre-anaesthetic and pre-Listerian days. For the rest it is a prejudice which we must do out best to dispel. It is not surgery that we need to dread, but the disposition to evade surgery until the condition is hopeless or nearly so, and then to blame surgery because the result is no better.

The medical profession is always endeavoring to discover better methods of cure. The most noteworthy contribution in recent years is the method devised by Professor W. Blair Bell of Liverpool. The principle upon which the treatment is based is that lead, like x-rays or radium, has a more deleterious action upon the cells of cancers than upon normal tissue cells. Colloidal lead, with which the best results are obtained, consists of particles of lead so finely sub-divided that they remain suspended in another

fluid for several days. This fluid is injected intravenously. In a paper in the *British Medical Journal*, April 17, 1926, Professor Bell reported his results to that date. Of 227 cases of cancer that were inoperable and therefore hopeless, 30 had been pronounced cured, in ten more the cancerous growth had been arrested, and nine more refused the complete treatment but are sufficiently improved to lead normal lives. Most of the remaining cases died.

Lead is poisonous, and the preparation used is still so unstable and difficult to prepare that it can only be used by experts trained in its administration. As a matter of fact the method is so dangerous that Professor Bell will not make it public until it can be further perfected. But although the method is at present only in the experimental stage, the fact that any inoperable cases have been cured in this manner is an important contribution and affords a hope for the future.

REFERENCES

(1) Pearl: Medical Biometry and Statistics. W. B. Saunders Company, 1923.
(2) Wells, H. Gideon: Cancer Statistics as they Appear to a Pathologist. *Journal of the American Medical Association*, February 5 and February 12, 1927.
(3) Howard: The Course of Mortality from Cancer in Baltimore. *Journal of the American Medical Association*, January 13, 1923, p. 71.
(4) Hoffman: The Mortality from Cancer throughout the World. 1915. The Prudential Press.
(5) Padua, Regino G.: The Need for Accurate Morbidity and Mortality Reports. *Journal of the Philippine Islands Medical Association*, October, 1925, vol. 5, p. 301.
(6) Dudley: The Prevalence of Cancer in the Philippine Islands. *Journal of the American Medical Association*, 1908, vol. 50, p. 1863.
(7) Vedder: The Incidence of Cancer in Filipinos. *Journal of the American Medical Association*, May 21, 1927.
(8) Slye, Maud: Some Misconceptions Regarding the Relation of Heredity to Cancer and Other Diseases. *Journal of the American Medical Association*, May 22, 1926, vol. 86, p. 1599.
(9) Bloodgood, Joseph C.: What Everyone Should Know About Cancer. Reprint of address in Baltimore under the authority of the Medical and Chirurgical Faculty of Baltimore.
(10) Cancer Control. Report of an International Symposium held under the Auspices of the American Society for the Control of Cancer at Lake Mohonk, New York, September, 1926. The Surgical Publishing Company of Chicago, 1927.

CHAPTER VIII

Modern Preventive Medicine

There are national, state, county and city services organized for the advancement of public health, in addition to the activities of hospitals and private physicians. The extent and correlation of these organizations are seldom realized by the general public and should be better understood.

THE UNITED STATES PUBLIC HEALTH SERVICE

The Public Health Service is the national organization. It is a bureau of the Treasury Department, administered by a Surgeon General. The personnel consists of about 200 regular commissioned officers and over a thousand reserve commissioned officers, the majority of whom are on active service. Counting internes, nurses, clerks and other employees the total personnel is about 16,000.

This large and important service has been developed from a small beginning. On July 16, 1798, Congress authorized a Marine Hospital Service to furnish medical care to sick and disabled American seamen. The first Marine Hospital was built at Norfolk, Virginia, in 1800, the second at Boston in 1802 and others were built at various times at important sea and lake ports. The medical officers serving at these marine hospitals were usually the first physicians to encounter epidemic diseases imported from other countries, such as cholera, yellow fever and smallpox, and the President authorized the Marine Hospital Service to aid the local health authorities in the control of these diseases. An act of Congress passed in 1878 gave the Marine Hospital Service power to coöperate with local health officers in preventing the introduction of infectious diseases into the United States. This was the origin of the present quarantine service. In 1893 the Marine Hospital Service was authorized to coöperate with local health agencies in preventing the interstate spread of all infectious diseases.

As additional functions were conferred upon the Marine Hospital Service from time to time, this name ceased to indicate its scope, and in 1902 the name was changed to the Public Health and Marine Hospital Service. At this time the Hygienic Laboratory was established in Washington and equipped for carrying on bacteriological, chemical, pharmacological and other medical researches. Finally, on August 14, 1912, Congress gave this service its present name, together with further broad powers to investigate the diseases of man and the pollution of navigable streams and lakes of the United States.

The present functions of the United States Public Health Service include:

Hospitalization of seamen and certain war veterans

This branch of the service furnishes hospital and dispensary treatment to part of the patients of the War Risk Insurance Bureau, to the United States Employees Compensation Commission, to the Coast Guard, the Merchant Marine and a few other classes including lepers.

Prior to 1919, the Public Health Service operated hospitals chiefly for seamen, with a capacity of about 1500 beds. On March 3, 1919, the service was authorized to furnish additional hospital facilities for patients of the War Risk Insurance, and the hospital service was rapidly expanded so that by 1921 it operated 61 hospitals with a bed capacity of 18,000. It makes over a million examinations of applicants for War Risk compensation annually, and has furnished over one million treatments to patients annually. The service operates a leprosarium in Carville, Louisiana, where lepers from all over the country are received for isolation and effective treatment.

Quarantine, or protection of the United States from the introduction of disease from foreign countries

This branch of the Public Health Service now supervises the administration of all quarantine stations of the United States and its insular possessions. All ships arriving at approximately 100 different ports are boarded and examined in order to prevent

the introduction of diseases like cholera, yellow fever, typhus fever, plague, leprosy and smallpox. Medical officers are also assigned to American consulates at important foreign ports for the purpose of enforcing the United States quarantine laws that apply at these ports of departure. The service also supervises the medical inspection of aliens at over 90 various ports of entry, to prevent the entrance of diseased persons.

Coöperation with local authorities in the prevention of interstate spread of disease

1. Assistance is given to the suppression of epidemics. Especially notable in this respect was the work in the suppression of plague which was introduced into San Francisco in 1900 and into New Orleans in 1919, and of yellow fever introduced into New Orleans in 1905.

2. The sanitation of interstate vessels and trains including examination of drinking water supplied by these common carriers and the control of travel by diseased persons.

3. The santitation of national parks to prevent the spread of disease by the travelling public in these government reservations.

4. Sanitary surveys. At the request of any local health authority the Public Health Service will make such a survey or investigate the outbreak of any infectious disease.

5. Assistance in control of special diseases such as venereal diseases and malaria. Nearly all of the states have now organized special divisions of their health departments for the control of venereal diseases and in coöperating in this work, the Public Health Service in 1920 supervised the operation of 427 clinics giving 1,576, 542 treatments for these diseases, as well as distributing millions of pamphlets of information on the subject. Assistance has also been given to many communities in the control of malaria, especially in rural districts.

Investigation of the diseases of man

This includes investigations in child hygiene, industrial hygiene, the disposal of excreta and stream pollution. Field studies have been carried on to determine the cause and method of prevention

of obscure diseases. These investigations have been especially fruitful in the case of pellagra, Rocky Mountain fever, chiefly found in Montana and Idaho, and transmitted by infected ticks, and in tularaemia, a disease never identified until recently and conveyed to people from infected rabbits. In the Hygienic Laboratory in Washington studies are made of the many problems involved in the cause and prevention of disease.

Supervision and control of biological products

Under the act of Congress of July 1, 1902, the Public Health Service supervises and controls the manufacture of biologic products, including smallpox virus, and other vaccines, therapeutic serums and similar animal products used for the prevention or cure of diseases of man. The various manufacturers of these products are licensed, the license being conditional upon an annual inspection of the plant to assure that the methods of manufacture are in accordance with the best technique and that the personnel is competent. At the close of 1926, 36 American manufacturers and 11 foreign establishments held such licenses. In addition the products of each firm are constantly tested for purity and potency. For example, each lot of antitoxic serum is tested on guinea pigs injected with a lethal dose of a standard toxin. If the antitoxic serum so tested falls more than 20 per cent below the number of units which it is supposed to contain, all of that lot of serum must be withdrawn from the market by the manufacturer. Since this entails great financial loss, manufacturers take care to make each serum more potent than claimed on the label. Thus if a physician purchases at any drug store, a vial of diphtheria antitoxin supposed to contain 1000 units he can be certain that he is actually getting at least 1000 units and probably more. The manufacture of about 100 different biologic products are subject to this supervision and the safety and certainty of action of these products that are so extensively used in the prevention and treatment of disease are thus assured.

Many drugs whose activity can only be gauged by animal experiment are standardized by appropriate tests. Arsphenamine (salvarsan) is an arsenical compound administered intravenously.

If it is improperly prepared or insufficiently purified, it is more poisonous than it should be, and might cause the death of the patient. Every lot of arsphenamine manufactured is tested by intravenous injection on rats and must pass this test for toxicity before it can be placed on sale for human medication. Insulin, used in the treatment of diabetes, digitalis used in the treatment of certain diseases of the heart, pituitary extract used by obstetricians to facilitate labor in childbirth, and other similar products are standardized by test on suitable animals.

Public health education

All health and quarantine officers are kept advised with regard to the prevalence of diseases in the United States and foreign countries by the publication and circulation of these statistics in a weekly publication, *Public Health Reports*, which besides contains much other information of value to sanitarians. In addition to these *Public Health Reports*, the results of special investigations are published in bulletins prepared by the Hygienic Laboratory and the Division of Scientific Research. About six million of such pamphlets and bulletins, exclusive of those relating to venereal diseases are issued annually.

The great value and importance of the United States Public Health Service is apparent, and this service deserves the support of all citizens in extending and improving its sanitary and scientific activities. In this connection it should be mentioned that approximately 1800 medical officers of the United States Army Medical Corps and the United States Naval Medical Corps, have as one of their most important duties the preservation of the health of their organizations, and from the very nature of their activities, have always kept informed upon all sanitary matters and have often acted as health officers in our island possessions and other isolated stations. Scientific research has also been encouraged, and is carried on officially at the Army Medical School, and the Naval Medical School in Washington, by a permanent Army Medical Research Board at Manila, Philippine Islands and by temporary boards appointed at various times for specific investigations in addition to the numerous investigations carried

out by individual officers. Many of the scientific advances in medicine and sanitation are the result of work by the medical officers of these two services. It is only necessary to mention the great contribution of Beaumont to the study of gastric digestion, the work of Reed and his co-workers on yellow fever, the development and introduction of typhoid vaccine, and the important additions made to knowledge of the causation and prevention of beriberi to show how valuable these services have been. These and many other important medical contributions as well as the numerous peace time activities of other branches of the Army and Navy should be remembered by those who object to these organizations. In the Army and Navy the nation is not only purchasing peace insurance but is also securing no little advancement of the public health, and other benefits that are hardly realized.

STATE AND CITY SERVICES

All of the states and larger cities have health departments. The organization of these departments differs in various places, but may be summarized under the following heads:

General administration

By a director who is responsible for the efficient operation of the entire department, and the proper expenditure of appropriations, which is controlled by an accurate accounting system. This official may be appointed by the governor or mayor but in the best organizations the department is out of politics and an efficient whole-time director is practically permanent. Unfortunately approximately 40 of the 100 largest cities are still (1927) provided only with part-time health officers, and in nearly 30 per cent of the cities the appointment of personnel is still subject to political changes. No such political organization can be as effective as one whose personnel is permanent and can devote their entire attention to the purposes for which the health department is created.

Each division of the department is headed by an assistant director having special qualifications for the particular work performed.

Registration of vital statistics

This includes deaths with causes, reportable diseases, marriages, births, and other data concerning changes in the population.

Death certificates are made upon a standard form adopted by the Bureau of the Census and the cause of death is given in accordance with a standard classification. A complete and accurate certificate of death is required of physicians not only as a legal obligation, but as a moral obligation to clients for the protection of their legal rights and interests, and as a professional obligation to further the advancement of medical science and sanitation. In any population the number of deaths from ordinary causes is quite constant and any increase in the total death rate calls for investigation. The death reports also give information as to the prevalence of different diseases, and, being compiled daily and weekly, give a warning as to the existence or spread of epidemic diseases.

Upon birth and death rates so collected, statisticians calculate the expectancy of life for any place or period, determine whether the population is increasing or decreasing, and make similar computations.

The registration area of the United States includes those states or cities where such records are accurately kept and in 1924 included 38 states and the District of Columbia and 14 cities in non-registration states, comprising 88.4 per cent of the estimated population and 90 per cent of all deaths. This was increased to 89.4 per cent of the estimated population in 1925. Since such records are well kept in all large cities, the improvement of these statistics depends upon the extension of reporting to the small towns and rural communities of the remaining non-registration states. Many people resent the questions of census enumerators, and the reporting of disease as an invasion of privacy. Registration of birth is valuable evidence in establishing identity, citizenship and rights of inheritance. A certificate of death is likewise necessary for the collection of insurance, and the probate of wills; and there is no family that does not benefit by the advances in medical science and sanitation that have been made possible by the collection of vital statistics.

General sanitation

This includes sanitary engineering or the provision of an adequate supply of pure water and the proper disposition of sewage; food and drug inspection, milk control, housing, factory sanitation and industrial hygiene, abatement of nuisances and other similar functions. The city or state is divided into districts with a sanitary inspector for each, so that continuous systematic sanitary inspection is carried out. All new construction is carefully investigated to see that the sanitary ordinances are complied with. Proper sanitary regulations combined with such inspection gradually eliminate tenement districts with their attendant insanitary conditions.

Prevention and control of communicable diseases

1. This division should be directed by a trained epidemiologist who can investigate the origin of all epidemics. It is only by determining the source of infection in this way and carrying out such corrective measures as are possible that the prevalence of infectious diseases can be reduced. In the case of diseases like typhoid fever, whose prevalence has already been greatly reduced, it is often possible to make a study of each case that occurs. In some instances this division is charged with venereal disease control, and the prevention and control of tuberculosis, while in some cities these important functions are performed by independent divisions.

2. In addition to this function which is common to states and cities, the latter maintain isolation hospitals where dangerous infectious diseases may be treated. This includes smallpox, and such cases of diphtheria, scarlet fever, measles and similar diseases as cannot be adequately and safely cared for at home.

3. This control of actual cases is supplemented by isolation of contacts who may be carriers of infection, the quarantine of houses when necessary and the application of such methods of disinfection as may be considered valuable.

4. The protection of individuals by vaccination against smallpox, inoculation against typhoid and immunization of children

against diphtheria. Such services are usually offered only to those who request them, except in the case of smallpox, when vaccination in certain areas of a city may be compulsory in order to end the danger of infection promptly.

Child hygiene

This includes the medical inspection and sanitation of schools, medical examination of school children, and such efforts as are made to reduce infant mortality, including in many cases maternity homes and infant welfare stations, where instruction may be given to mothers concerning proper methods of feeding, and the provision of a safe milk. Some cities even provide dental clinics for children.

Laboratory service

This service gives aid to all the other divisions, making chemical and bacteriological examinations of water, milk and other foods, examinations of sewage when sewage filtration plants are used, and by the performance of many diagnostic tests. Any physican may submit specimens for such examination from cases of suspected diphtheria, tuberculosis, malaria, typhoid fever, gonorrhoea, syphilis, glanders, rabies and other infectious diseases. A microscopic examination may be made of tumors to determine their type and the possible existence of cancer. Some laboratories also produce antitoxic sera and other immunizing agents for free distribution to the poor. Many of these laboratories also carry on research work for the development of better diagnostic tests and upon any other problems whose solution would aid in the prevention and control of disease. Some very notable contributions to scientific medicine have been made by these state and city laboratories. Such laboratories have been maintained by all large cities for many years, and by 48 states as early as 1914.

Social service, performed by public health nurses

Such a division is maintained by many cities in order that those who are unable to employ a regular nurse, may thus receive the services of a trained nurse. Public health nurses make daily

visits to a series of such cases, spending the time with each case that is necessary to provide essential nursing, to give instruction in the prevention of infection, and such other assistance as may be necessary. This service is peculiarly valuable in the care of cases of typhoid, tuberculosis, sick infants, and all cases that cannot be removed to hospital. This situation arises frequently in poor families where the mother is sick. The man cannot remain at home because he must work to provide the necessary income, and the mother must remain at home when there are young children that cannot be left alone. The situation of such families is desperate. It is frequently relieved by the voluntary services of neighbors, but these are often ignorant people who know nothing concerning nursing or the methods of preventing infections. Such well meaning efforts may result in the wide spread of infections. The public health nurse fills this gap.

Education and publicity

This includes the annual report of the department which, giving a summary of the work of the year and condensed statistics, forms a very valuable fund of information for the guidance of future work. One state or city can thus compare their results with those of neighboring communities, and methods found valuable in reducing mortality in one state or city may be more widely adopted. Usually monthly bulletins are also published. The results of research work or advances in sanitation are embodied in scientific papers published in journals that reach those for whom such results are intended. Education of the public is attempted by leaflets or pamphlets giving facts concerning specific diseases and the activities of the health department, and distributed widely in the community.

In some cities official newspaper talks are given out by the department. This is an activity that deserves to be extended. Newspaper talks are in bad odor with the medical profession because they are so often conducted by individuals who have no qualification for such employment except a brazen assurance. Private physicians, however well informed, cannot give newspaper talks without violating the ethics of the profession concerning

personal advertisement. But there is no reason why authentic information of value concerning disease should not be given to newspapers by medical societies or public health services and every reason why it should be. The newspaper reaches everybody, and is the medium by which such information could be most widely and quickly disseminated, and when given out by such official organizations it involves no personal advertisement.

Exhibits of public health activities have also an important place. When properly prepared they attract attention, and much can be learned from them by the public concerning the cause of diseases and methods of avoiding them.

COUNTY HEALTH SERVICES

Local officials such as sheriffs, tax collectors, superintendents of schools, and highway commissioners, are usually elected by or appointed for the county. Except in the case of large cities, the county is the logical administrative unit for the health service also. A county organization is required to reach the rural districts. State organizations do their best, but their functions are logically confined to those projects that affect the people of the entire state, such as the impounding of water sheds; the control of sewage disposal in rivers so that one city will not discharge untreated sewage to poison all the communities that are compelled to use this water supply; the establishment of central laboratories, and similar activities. Dr. Nicoll, the Commissioner of Health for New York State, has said that we have about reached the limit of results attainable by such methods. He was referring only to New York, which has one of the best of the state health services, but his remark is broadly applicable. No state service as at present organized, can provide an intimate contact with scattered country inhabitants.

In spite of these facts county organizations have developed slowly in most states. There are 3065 counties in the United States, of which 2087 are rural. The first county health service was established in 1911, and in 1924 only 250 counties in 35 states had health organizations of some kind, and only 146 had full time county health officers. This was increased to 307 by 1926.

According to the 1920 census the rural population was 51,406,017, and in 1924 only 6,439,852 or 12.52 per cent of the total was provided with a local health service under the direction of a whole-time health officer. 87 per cent of our rural population are not provided with even a reasonably adequate health service. This fact is reflected in mortality statistics. The large cities now have uniformly lower death rates than those of the surrounding rural population. Since 1921, the general death rate for Chicago has been consistently lower than that of the rest of the state. For 1923 the general death rate per 1000 for Chicago was 11.7, and

TABLE 52

Mortality rate per 100,000, United States Registration Area, from certain preventable causes 1900–1922 for cities and rural districts and per cent reductions

DISEASE	CITIES			RURAL		
	1900	1922	Per cent reduction	1900	1922	Per cent reduction
Typhoid fever	28.5	4.8	83	34.6	10.0	71
Malaria	5.4	0.9	83	7.2	6.0	17
Measles	16.4	4.1	75	9.8	4.5	54
Scarlet fever	11.9	3.6	70	6.8	3.4	50
Whooping cough	14.4	5.5	62	9.8	5.6	43
Diphtheria	52.4	15.6	70	26.5	14.0	48
Tuberculosis lungs	204.1	83.0	59	138.0	85.0	38
Diarrhoea and enteritis (under two years of age)	116.0	35.1	70	56.2	30.0	47
Total	449.1	152.6		288.9	158.5	

was 12.3 for the remainder of the state. In the registration area in 1922 the death rate per 100,000 for all epidemic, endemic and infectious diseases was 180.4 in the cities and 186.3 in the country. The reason for this is shown by table 52.

As early as 1662, John Graunt who then originated the study of vital statistics, discovered among other things that death rates are normally higher among urban than rural dwellers. It has been accepted ever since as a truism that the country is healthier than the city. So far as the preventable diseases here tabulated are concerned, this was still true in 1900 in spite of the higher

typhoid and malaria rate in the country. But by 1922, it was actually healthier in the city thus reversing the natural course of mortality, because in the case of each disease the percentage of reduction was far greater in the city than in the country. There could be no stronger argument to prove that an efficient health service actually does reduce the mortality.

A striking example of the results accomplished by a reasonably adequate whole time county health service is afforded by Madison County, Alabama. This county has 811 square miles with a population of 52,535. Vital statistics have been kept since the department was organized in 1918, and the following death rates per 1000 have been recorded.

Year	1918	1919	1920	1921	1922	1923
Rate	26.2	15.4	15.0	12.6	13.6	14.3

Today of approximately 13,000 homes, 70 per cent have sanitary toilets. During the past year among other activities, 42 milk supplies were radically improved as the result of 400 dairy inspections made and 3000 cows were tested for tuberculosis. Extensive drainage and other measures for malaria control were carried out and attention was given to the prevention of disease in early life by maternity and infant clinics, school inspections and child hygiene. There were given 1581 typhoid and 942 smallpox vaccinations. Venereal disease control was attempted. 950 patients were treated for syphilis and 1066 for gonorrhoea. In the course of educational work, 243 lectures were given to 19,000 people, 9446 health bulletins were distributed, 334 newspaper articles were written and there were 27 exhibits of health films. This work was performed at a cost of $19,082.73 or 36.5 cents per capita.

Another example is afforded by Harrison County, Mississippi, where the annual average rate for malaria from 1915 to 1917 was 1585. Under a full time health department this rate was reduced as follows:

Year	1918	1919	1920	1921	1922	1923
Rate	851	473	205	112	152	58

The organization of such a county health department must be determined by the resources of the county. The average rural population of a county is about 17,000. In initiating such a service, the minimum is a full time health officer who should be a licensed physican having some sanitary training and possessing tact and energy. As the value of the service is demonstrated, the staff will be increased. For a county of about 25,000 population, a satisfactory staff would include the health officer, a technician who would act as clerk and laboratory assistant, a sanitary inspector and a public health nurse. This staff could be acquired at a minimum cost of $10,000. The first county health unit in New York State was established in Cattaraugus county in 1923 when the health budget was $9,300 which was raised to $16,000 in 1924. A county laboratory service is most useful, but not essential since specimens can be sent to the state laboratory.

The United States Public Health Service has endeavored through every possible means to encourage the development of county health services, but it is believed that the state should take the initiative in establishing county health work by assisting in choosing the local health officers, furnishing technical information and maintaining a general supervision. It has been suggested that the coördination of state and county health authorities can be best accomplished through a state subsidy, which also gives encouragement to the counties to initiate health services.

HOSPITALS

Hospitals and hospital facilities have been increasing rapidly. In 1909 there were only 4359 hospitals in the United States with 421,056 beds. By 1918 this was increased to 5323 hospitals with 612,251 beds. In 1926, excluding some deemed unworthy of inclusion in these statistics, there are now listed 6946 hospitals having a total capacity of 859,445 beds. During this last year there was an increase of 50 hospitals and 22,869 beds. (*Journal of the American Medical Association*, March 12, 1927.) The national investment in hospital plants and equipment has been estimated at considerably in excess of two billion dollars. More than one hundred million dollars is invested in hospital property in Pennsylvania.

THE FUNCTIONS OF A HOSPITAL

Originally designed merely to care for the sick, the hospital now has other important functions including the training of physicians and nurses, medical research, and the prevention of disease.

The training of those who care for the sick not only accomplishes the primary purpose of the hospital but is the best method by which the healing art may be acquired. In those hospitals associated with medical schools, the medical students receive instruction in clinics and ward classes. In all hospitals patients are cared for by visiting physicians of great skill and experience who act as chiefs of services and who are often professors in a medical school, and their advice is carried out by the resident medical staff called internes. These are selected young men who have recently graduated in medicine, and enter the hospital to acquire several years of active experience under the direction of the very capable men who act as chiefs of the various services. In 1926, 578 general hospitals provided interneships for 4952 graduates in medicine.

All the larger hospitals also maintain schools for nurses. There were 2155 such training schools in 1926, with a total enrollment of student nurses of 76,527. In addition to a regular course of study by lectures and recitations, student nurses receive instruction in the wards in the care of the sick under the instruction of the visiting physicians, internes and graduate nurses. As the result of the work of these schools, there are 327,045 registered trained nurses or 28 for each 10,000 people in the United States although they are not distributed equally. The largest number in any state is found in New York where there are about 105 registered nurses to every 10,000 people and the lowest supply is in Georgia and Mississippi which have only 7 per 10,000. The assistance given by these nurses in preventing the spread of infectious diseases and in other public health functions can hardly be overestimated, and is undoubtedly one large factor in the general reduction of mortality rates.

In addition to these registered nurses who are graduates of hospital schools, there is an unknown number of nurses who have

received a certain training in unregistered institutions or by correspondence. It is possible to give theoretical instruction in nursing by correspondence, just as it is possible to give instruction in swimming on dry land. But after the motions have been learned in this manner, the only way to swim is to go into the water and acquire facility in performing them. Similarly the only way to learn the nursing art is by actually caring for the sick. Graduates of correspondence schools of nursing are just at the stage of entering the water.

MEDICAL RESEARCH

Studies in the basic medical sciences may be carried out in laboratories divorced from hospitals, but many of these investigations can be prosecuted more readily in hospital laboratories where materials from patients are available for study. Scientific advances in clinical medicine depend entirely upon the actual study of patients. The Rockefeller Institute for Medical Research, an organization entirely devoted to research medicine, found it necessary to build its own hospital to provide such clinical facilities. In addition to such laboratory and clinical research, the hospital keeps a complete record of each patient. By assembling and correlating the information that is contained in these individual histories, statistical information of great value is obtained. It is from such records that we learn the percentage of fatalities following certain operations, the value of certain methods of treatment, the percentage of cures possible in diseases like cancer, and innumerable other facts which eventually become a recognized part of medical teaching.

PREVENTION OF DISEASE AND PROMOTION OF HEALTH

Cases of infectious disease are not only isolated or so treated in hospital that they no longer spread infection to others, but the hospital should promptly notify the proper health officer of each such admission. This enables the health department to take the proper measures in the family or neighborhood from which the patient came. In addition to this important service which all hospitals render, it has become increasingly evident that hospitals

should serve as educational centers. Patients of intelligence can hardly live in a hospital without acquiring many ideas concerning the cause and prevention of disease and sanitary methods in general. In addition to such information which is absorbed by contact, hospitals should make a definite effort to provide suitable instruction for each patient when convalescent. This may be done by personal instruction by internes and nurses, by issuing such pamphlets or other health literature as can be obtained from city, state and government publications, and through the hospital library. Most hospitals have a library for the entertainment of convalescents. Such libraries should contain elementary and interesting books on hygiene and sanitation. Hospitals also give important instruction in the special clinics that are now being organized. These include clinics for infants, nutritional clinics, cardiac clinics, and tuberculosis clinics where large groups of patients are given special education according to their needs. Hospitals may also hold public lectures on health topics.

In the absence of sufficient convalescent homes, patients leave the hospital before they are able to return to work. In many hospitals contact with such patients is now maintained by social service nurses. This service offers an excellent opportunity to carry instruction in the maintenance of health to other members of the family.

Like other human institutions, hospitals may be improved, yet the medical service that they now render is satisfactory in all essential respects. Entering any good hospital, one feels assured of competent medical attention and nursing in a comfortable room or at least a bed with good food appropriate to the occasion. The American College of Surgeons has as one of its functions, the standardization of hospitals. To obtain their approval hospitals must possess a satisfactory personnel and equipment and must employ those methods of caring for the sick that have received the endorsement of the leaders of the profession. In 1924, the American College of Surgeons surveyed 961 hospitals of 100 beds or over, of which 837 or over 87.1 per cent received their approval. Such a survey is conducted annually. There are twelve million patients passing through the hospitals of the United States and

Canada each year. The old days when people were justly afraid to enter a hospital are gone forever.

Nevertheless, people still dread the hospital today for a different reason, namely, the expense. The rich can afford to pay any price, and the very poor are received free of all charge in most hospitals, but these are small fractions of the population. Incomes of $6000 or over are received by 1.66 per cent of the population. Over 55 per cent of all incomes are between $1000 to $3000. The great middle class receiving incomes of from $1000 to $5000 form the great bulk of the population, and expect to pay their way; but a month in hospital at from $200 to $500 is somewhat excessive and a great drain on their small incomes. When a member of such a family is obliged to remain in hospital for three or four months, it is a catastrophe that may wipe out all their small savings. This is a bad situation.

There is nothing to be gained by blaming the doctors or the hospitals. If doctors and hospitals are to exist they must receive sufficient funds for maintenance. With few exceptions the incomes of physicians are not large. One statistician has stated that the average annual income of the American doctor was $1200 for the year 1919. Doctors who deal with invaluable lives are not paid nearly so well as those lawyers who merely deal with property. Physicians attend poor patients in hospitals free of charge, and the fees from private patients are no larger than those for similar attendance in their own homes. It is the hospital charges that run into big figures. Many hospitals charge $10.00 a day for a private room exclusive of nursing and medical fees. This appears excessive, but a similar room and meals in a good hotel would cost about the same. It costs more to feed a patient in a hospital than a guest in a hotel, for there are many special diets, and all are served at the bedside. The overhead expense of a hospital is enormous. Without considering the capital invested, which may have been received from the state or from private philanthropy, a very large staff of nurses and orderlies is required. Nurses in training receive only nominal salaries, but recent developments in medicine require trained and paid nurses in larger numbers, and orderlies must receive a living wage. A hospital

has no eight-hour day, and both day and night services must be maintained. All of this staff must be fed and provided with room and laundry. There is a continuous expense for supplies. Cotton and gauze for surgical dressings are expensive even at wholesale. Drugs are cheap at wholesale prices, but there must be a paid pharmacist ready at all times to compound them, and all biological products are expensive. Replacement of instruments, appliances and bedding and the purchase of new equipment is a further heavy charge. No hospital is complete today without a good laboratory and x-ray equipment. All of this overhead must be paid out of funds received from patients unless the hospital is supported by the state or privately endowed.

For the year 1926, the per diem cost of a ward patient at the hospital of the University of Pennsylvania was $5.00, and the cost of caring for each patient in the general hospitals of the United States Army was $4.84 a day. Very few hospitals can operate more economically and for many the per diem cost for each patient is higher. When it is considered that many patients pay nothing, and that the operating expenses must be collected from those who do pay, it is not astonishing that it costs as much to live in a hospital as at a hotel.

This is a simple economic problem, and can only be met by providing hospitals with a sufficient endowment to enable them to charge lower rates. Army hospitals in which a large part of the expense is paid by the government are enabled to treat officers and their families at a rate of $1.50 per day. A bulletin published by the Department of Public Welfare of the state of Pennsylvania showed that 69 state aided hospitals reported endowment at a rate of $1559 per bed for each patient. In 149 state aided hospitals, the daily per capita cost of maintenance was $4.14, of which the patients contributed $2.73 and the remainder was contributed by state or local aid and from endowment earnings. The Good Hope Hospital Association of Los Angeles has a fund of more than $2,000,000 dollars invested in securities, for the purpose of aiding persons earning small salaries to pay their hospital expenses. The hospital collects from patients such amounts as they are able to pay and the Good Hope Hospital association pays the differ-

ence between that and the actual per capita cost. Since hospitals give universal service, they should be supported, at least in part, by local taxation. There is probably no more desirable philanthropy than the endowment of hospitals. When hospitals are so supported or endowed, people of moderate incomes can obtain treatment by the payment of fees that will not seriously embarrass them.

Since hospital beds are so expensive, they must obviously be reserved for the seriously sick. In the past many patients have been admitted to hospitals as a matter of convenience when they could have been properly treated by their physician at home, or by attendance at an out-patient department or dispensary of a hospital. Hospitals have always maintained such out-patient departments, and in recent years have been building more capacious clinics for out-patients in order to reduce the pressure on their wards. The American Medical Association listed 3294 dispensaries in the United States in 1922 with enough additional institutions estimated, to bring the total to 4000. About 8,000,000 patients made a total of 29,500,000 visits to them.

An objection has been raised by many physicians to the unlimited extension of free clinics that in many instances serve, not the patients who cannot pay for services, but a pauperized element who can pay but will not. "The two worst economic sins are trying to get something for nothing and willingly giving something for nothing." The establishment of free clinics is practically a form of state medicine which is everywhere ruinous to medical practice. This objection is readily met by establishing such clinics on a paying basis. A notable experiment in a self-supporting out-patient service is the pay clinic conducted by Cornell University Medical College in New York City. With an admission fee of $1.50 and special fees for medicines, x-rays, laboratory tests, and other special examinations the average cost per patient is $2.25 per visit. The second annual report of this institution indicates that this income renders it self-supporting.

PRIVATE PRACTITIONERS

There were listed 164,002 registered physicians in the 1926 directory of the American Medical Association. Of these approx-

imately 1000 were in dependencies of the United States, and about 10,000 in Canada. The remainder are in the United States which therefore has approximately one physician to every 700 inhabitants.

In the past the chief function of these physicians has been the diagnosis and treatment of disease, and their public health duties have been usually limited to the reporting of births, deaths and cases of infectious disease, performing vaccinations when requested, and the education of their patients.

During the past twenty years there have been important changes in the practice of medicine. The rapid advances in the medical sciences have made it impossible for a man, however studious and diligent he may be, to keep abreast of the times in all branches of medicine. This has resulted in the development of many specialities. The specialist has many advantages over the general practitioner. He is enabled to become an expert in his department and by his skill and his ability to contribute to the advance of knowledge he acquires a reputation, and difficult cases are referred to him in increasing numbers. He therefore lives in a city, his work is limited to a consulting practice, and he enjoys easier hours, and a larger income than the general practitioner. So far as the patient is concerned, if his case is at all difficult, the prospects of improvement are vastly increased by this ready availability of technical skill. The expense of treatment is also greatly increased, for not only are the specialist's fees larger, but laboratory, x-ray and other expensive tests and examinations are required in order to arrive at a correct diagnosis. Often the patient is referred from one specialist to another, so that illness becomes more and more an expensive luxury.

In order to correct this difficulty, a number of specialists have often formed a group, under the leadership of one of their number who is especially skilled in diagnosis. Patients coming to this group are first examined by this specialist in internal medicine, the necessary tests are made by the laboratory member of the group, and the patient is referred for treatment to the proper specialist. This group practice has both advantages and disadvantages for the physician, but at least the patient receives a

complete examination and treatment for a single fee, usually much less than would be charged by a number of specialists working independently.

Another method often suggested to reduce the cost of medical attendance is some form of state medicine. In such a system the government either employs the physicians at a fixed salary, or defrays the whole or a fixed proportion of all charges for medical attendance. Such systems are in use in Great Britain and Germany today, and do not produce good results either for the physician or the patient. Doctors are highly educated men in a profession of high ideals, but it is only in accordance with human nature that under such a system the acute interest in the patient is somewhat diminished. The average salary of the profession is usually reduced under such a system. Even though the average salary were increased, the earnings of the best men upon whom we must depend for progress in the science and art of medicine are inevitably decreased, and the best men are no longer attracted to the practice of medicine. A medical bureaucracy is founded, with an increase of taxation and in the cost of government, which has already become unbearable. A bureaucratic administration of medical affairs is fatal to the progress of medicine and it has been stated that under this system Germany has come to have the worst medical service in the world, and the poorest care for the health of the people. No physicians or well informed laymen desire state medicine in the United States.

We have, however, come dangerously close to it. It is perhaps not generally realized that Congress has authorized the treatment of all war veterans in government hospitals at government cost. This means that 4,000,000 men or nearly 20 per cent of the adult male population of the United States can receive free treatment for any condition for the rest of their lives, the cost to be paid out of federal taxation. It may be freely admitted that the people as a whole are under a direct obligation to provide proper treatment and support for those who received injuries in the course of their war service, but this is a comparatively small number. There were 224,089 admissions to hospital for all battle injuries, of whom 13,691 died and 20,588 were discharged for disability. The

majority of the remaining 189,810 cases were not permanently disabled. So far as disease is concerned, the war army was chiefly demobilized during 1918–1919. All soldiers having 10 per cent or more disability were reported to the Bureau of War Risk Insurance as prospective beneficiaries, and discharged on a certificate of disability. The total number so discharged in 1918–1919 constituting the great majority of the war disabilities, was 33,536, making a grand total of 54,124 for practically all disabilities caused either by wounds or disease during the war. (*Report of the Surgeon-General of the Army, 1920*, pp. 57 and 125.)

By no stretch of the imagination have we become obligated for the future medical care of more than 100,000 men. Of the drafted men 2,000,000 never left the United States and were discharged in good health, and it is difficult to understand why the taxpayers should be saddled with the medical care of these men for the rest of their lives, or with the care of those who returned from France and were discharged in good health. The cost of this care and treatment already amounts to millions of dollars annually and will inevitably increase as these men become older. This is a strange expenditure when economy is supposed to be the watchword.

Recent advances in sanitation have caused a remarkable decrease in the prevalence of many diseases that formerly occupied much of the time of the general medical practitioner. The increase in specialism, in free treatment by government hospitals, in free dispensaries, and treatment by the various cults such as Christian science, chiropractic and osteopathy have resulted in a further considerable decrease in the opportunities for the general practitioner of medicine. This is unfortunate for the patient as well as for the doctor because about 90 per cent of all illnesses can be treated by the family physician to the best advantage of the patient. In the remaining 10 per cent of illnesses requiring special examinations or treatment, the general practitioner, by reason of his medical acquaintance, is still the best qualified man to refer his patient to the proper specialists. It passes understanding that otherwise intelligent and educated people will drug themselves with patent medicines, or submit themselves to the manipulations of a chiropractor, who may have previously been a

plumber or a plasterer, and whose knowledge of medicine is limited to what he could acquire in a three months course entirely devoted to the fanciful idea that all diseases are caused by the misplacement of one of the vertebrae. Such educated people would be the first to call in an architect if they wanted a house designed, an engineer if a bridge was to be built, or a lawyer if a contract was to be signed. They realize that such activities require special education and training that they do not possess. But when it comes to a question of medicine, probably the most complex of all the biological sciences, they will blithely prescribe for themselves and recommend remedies to their neighbors, or will submit themselves and their families to the ministrations of charlatans who do not know on which side of the diaphragm the liver is located, and who think that the bones of the vertebral column slip about like a man on a banana peel.

The belief in the magical properties of some object like a horse chestnut or a rabbit's foot, or of the special abilities of witch doctors, faith healers, and others of that ilk, is as old as humanity. The names and the methods change, but human credulity and self deception in medical matters are the same now as in the days of Hippocrates. It is hopeless to expect any great change in public sentiment on this topic. "Ephraim is wedded to his idols."

Since the ordinary practice of medicine is becoming limited, the logical remedy for the physician is to branch out and increase the value of services rendered. In the past, the family physician was only called in when there was sickness to be treated. A considerable percentage of this sickness could be prevented, and this is the doctor's great future opportunity.

We have all heard of the alleged Chinese custom of paying a physician while in good health and stopping his pay as soon as illness developed, on the theory that it is then to the physician's interest to cure his patient as soon as possible. Such a system is irrational and an insult to the doctor, but it contains a germ of truth. Why would it not be sensible to pay the family physician to endeavor to keep the family well in addition to paying special fees for treatment when they are sick? In inaugurating such a system, the family would agree to pay the physician a definite sum

each year, payable monthly, quarterly or semi-annually according to convenience, for his services in preventive medicine. These services could include at least the following items:

(a) An annual physical examination of each member of the family and such additional periodic examinations as the first examination indicated to be necessary. The results of these examinations should be recorded on appropriate forms, together with any corrective measures recommended. Some supervision would also be maintained to assist in carrying out the recommendations for correction of defects. In the course of these examinations, an accurate medical history would be taken, with a record of the diseases already suffered, and the hereditary or other possible susceptibility to future disease. Such an adequate examination would result in a complete and up to date medical record of each member of the family, filed so as to be instantly available, and in a few months would give the family physician an intimate medical knowledge of his patients such as is usually acquired only after a number of years of ordinary practice.

(b) It would next be the duty of a physician so employed to see that each member of the family was properly immunized against all infections for which such protection is available. This includes proper vaccination against smallpox and typhoid fever, immunization of children against diphtheria, the administration of tetanus antitoxin, in all cases in which wounds have been received of such a nature as to render this advisable, and possibly even the immunization of pet dogs against rabies to prevent the possibility of such an animal becoming infected and biting one of the members of the family. In some cases it will also be possible to give protective injections of convalescent's serum or antitoxic sera to young children that have been exposed to measles and scarlet fever.

(c) The physician should keep informed concerning the prevalence of any diseases occurring in the general community or in the schools, and give the family instructions necessary to enable them to avoid such infections so far as possible.

(d) A sanitary inspection of the domicile with appropriate advice concerning possible improvements. This would include heating and ventilating devices, screening, etc.

(e) In rural districts where an official health service is not operative, or is not highly efficient, such an inspection would include disposal of wastes and an examination of the water, milk and other foods. Such specimens would be collected and sent to state laboratories.

What, may we ask, would be a reasonable remuneration for such services? Only a tentative estimate can be made for the fee would depend upon the age and experience of the physician undertaking such services and the economic status of the families served. With a reasonable systematization of the work, it should be possible for a physician to so care for 100 families. If each family paid $100 a year for the service, the physician would receive an income of $5000 per year, a sum greatly in excess of the average income of physicians in the United States, and more regularly collected. If they paid but fifty dollars a year, the physician would still receive $2500. These incomes would be increased by the regular fees for ordinary medical attendance, but the fees so derived would inevitably decrease in proportion as success was attained in the prevention of disease.

This is a new departure and many families might not care to adopt it. However they should all be educated to demand and pay for periodic physical examinations which should be conducted by the family physican and such examinations should commence with the birth of the child. The benefit that may be derived from periodic physical examinations and the correction of defects has been mentioned several times in these pages.

Such examinations are by no means a new procedure. In many cities some form of examination of school children has been performed systematically and the correction of the defects detected has often been followed by physical and mental improvement. Many of the larger life insurance companies are now offering to perform an annual urinary examination free of charge for their policy holders, and in some cases, a complete physical examination is offered. Insurance companies find that the prolongation of life so attained pays dividends in actual cash. The National Safety Council is an organization representing 4300 industries of the United States and was organized originally to protect working

men from accidents. It was soon learned that the time lost from sickness was about seven times as great as that lost from accidents, and attempts to conserve the health of employees naturally followed. Nearly all of these industries employ physicians for this purpose, and in many cases this service includes annual physical examinations.

An annual physical examination of every officer of the United States Army was authorized in 1907, and has been a regular practice since that date. The results of these examinations are recorded on standard forms, and since 1919 each officer is informed of any defects found, and a suitable recommendation for correction is made in each case.

Officers of the army are physically a very superior class owing to the fact that each one must pass a severe physical examination before he is accepted and is presumably physically sound and in good health at that time. Yet the number of physical defects found in such officers annually is very considerable. A study of the physical defects found in 11,789 officers during the year 1924 was made and published in the annual report of the Surgeon General for 1925. A total of 13,430 defects were noted, occurring in 8110 individuals.

Defective teeth occurred with greater frequency than any other defect, the incidence rate being 244.6 per 1000. Abnormalities of the nose and throat ranked second in frequency, the rate being 143.3 per 1000. Overweight (10 per cent and over) occurred at a rate of 137.9 per 1000. Arterial hypertension (systolic 140 mm. and over) occurred at a rate of 89.07 per 1000. There were 497 abnormalities of the eye and 217 abnormalities of the ear, 25 cases of active chronic tuberculosis of the lung, 40 cases of organic heart disease, 33 cases of nephritis, 36 cases of syphilis, 151 diseases of the digestive system, 91 hernias (ruptures) and 4 cases of diabetes, among many other defects.

The great importance of the early recognition and treatment of such conditions is self-evident. If such a large number of defects develop in a rigidly selected personnel presumably living in good hygienic circumstances, and with free medical attendance always available, what, may we ask, are the defects that occur among the

less favored individuals of the general community? Many of these facts are widely known with the result that a number of the more progressive individuals are already demanding such physical examinations of their physicians.

Periodic physical examinations of the apparently healthy as a preventive measure is also strongly endorsed by the American Medical Association which has gone so far as to issue a *Manual of Suggestions for the Conduct of Periodic Examinations of Apparently Healthy Persons.* This manual contains suitable forms for recording the medical history and physical examination.

INSTRUCTION IN SCHOOLS

Some instruction in anatomy, physiology, hygiene and first aid is eminently desirable for all individuals, and is of far more practical use than arithmetical drill in solving complex fractions, the parsing of sentences, and other mental gymnastics that have little bearing on the future life of the individual. Instruction is at present supposed to be given on physiology and hygiene in the public schools; but most graduates of high schools and colleges have but the vaguest ideas concerning the location and function of important organs, of the causes of disease, or concerning the elementary principles of hygiene. This is largely because the teachers of this subject know nothing of it except what is contained in the text book, while those responsible for the selection of school books insist that books on physiology and hygiene should devote the majority of their attention to horrible examples of the effects of alcohol and tobacco. This is insisted upon for the same reason that the "mentalfuddleists" insist that evolution must not be taught. Evolution conflicts with their idea of the teachings of the Bible, therefore it is not a fact. The use of alcohol or tobacco is believed to be immoral, therefore it must be taught that they are always harmful. If our ideas of religion and morality conflict with the actual facts of the universe in which we live, so much the worse for the facts. There was never a better prescription for keeping people in perpetual ignorance.

In the case of alcohol, it is at least true that its *abuse* is followed by many harmful results to the body, but it is very hard to make

out a case against tobacco. School textbooks are filled with "sillygisms" like the following: A drop of pure nicotine placed on the tongue of a cat will kill it. A strong cigar may contain a drop of pure nicotine. These statements may possibly be correct, but the fact is suppressed that the cigar is not to be swallowed, but smoked, and that the heat of combustion destroys the nicotine. The natural conclusion for the child to draw is that anyone who smokes a cigar or a package of cigarettes is courting sure death and destruction. The child learns this inspired tommyrot. But at home he daily observes his father smoke several cigars, pipes or cigarettes, which not only does not cause him to drop dead, but does not appear to have any perceptible effect on him except to make him rather more cheerful and easier to approach for small favors. The result is that the child not only loses confidence in the entire subject of physiology, but in the teacher, who may or may not believe, but at any rate is compelled to teach such balderdash.

This condition cannot be corrected until leaders in the community cease to regard schools as the place to teach religion. The place for this instruction is the home or church and schools should be limited to the teaching of facts in the firm conviction that the truth can never be immoral, and in the development of those good habits, the sum of which constitute character, probably the most essential asset in life. Morals and character are not learned from teaching or preaching but are gradually inculcated as the result of living with people who exemplify moral principles and good habits in their daily life.

REFERENCES

(1) The United States Public Health Service: Its Evolution and Organization. Public Health Reports, May 27, 1921, vol. 36, p. 1165.
(2) Lumsden: Extent of Rural Health Service in the United States, 1920–1924. Public Health Reports, 1924, vol. 39, part 1, 1127.
(3) Municipal Health Department Practice for the year 1923, based upon surveys of the 100 largest cities in the United States. Public Health Bulletin No. 164, xviii, Government Printing Office, Washington, D. C.
(4) Rural Health Work in New York State. Public Health Reports, 1924, vol. 39, part 1, 618.
(5) Parran: The County Health Unit. Illinois Medical Journal, April, 1926, p. 334.

(6) Work of the Madison County (Alabama) Health Department. Public Health Reports, 1924, vol. 39, part 1, p. 615.

(7) LEATHERS: Fundamentals in the Development of a County Health Department. *Journal of the American Medical Association*, August 2, 1924, vol. 83, p. 315.

(8) MARTIN, H. NEWELL: The Human Body. 11th edition, 1926. Henry Holt & Co., New York. An excellent book for high schools, colleges, and general reading, describing the structure and activities of the body, and the conditions of its healthy working.

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